THE

ELECTRICAL REVIEW.

VOL. XXXIII. DECEMBER 8, 1893. No. 837

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ELECTRIC LIGHT MAINS.

REFERRING to the letters of Prof. Kennedy and Mr. R. E. Crompton in last week's issue, we regret that we cannot accept the generous offer of the latter gentleman to assist us in investigating the merits of his system. We purposely stated that we had no intention of taking up the case of bare *versus* insulated mains. Furthermore, we are already perfectly satisfied as to the excellence of Mr. Crompton's bare wire or strip system in culverts, and readily concede all that he claims for it; such an investigation would not assist us in getting facts regarding explosions in other systems.

We pointed out the liability of explosions in junction boxes, and although Mr. Crompton states that in nearly every case they are due to coal gas, and in no case due to electrolytic gases, there are no proofs of his statement being the correct one.

It is impossible to tabulate anything regarding the explosions which have occurred; the explanations are so conflicting and opinionative, that no reliance can be placed on them. We therefore did not state what was actually the cause of any particular explosion, but suggested the various ways in which they could be brought about, in junction boxes and in bare mains in cast-iron troughs.

It is for those in charge of mains or systems in which explosions happen, to make the fullest possible investigation, to ascertain all the facts, and publish them, so that the real state of the case may be given. The fact that Mr. Crompton's mains have performed their work for years without one single case of an explosion, is a proof that he has succeeded in designing a system in which the various ways of producing such disasters have been studied and rendered next to impossible.

The first explanation from Glasgow regarding the explosion there, was "that an accumulation of gas in the conduit had been exploded by a spark from a testing wire." Now, our remarks have brought out the information from Prof. Kennedy that the explosion was due to a short circuit on a "treble potential lead" in a cast-iron pipe. This information is not much; a short circuit is surely a serious enough affair on an underground wire or cable, or whatever is meant by a "treble potential lead." The copper strip in the cast-iron troughs may not have been the cause of the explosion, but in the face of the admitted fact that one of the leads in the system short-circuited and caused the mischief, we cannot allow that our statement of the case was in any sense "absolutely untrue." We have no doubt whatever that Prof. Kennedy's explanation is the correct one. Why the first view was ever put forward it is difficult to say; it had every appearance of improbability, and we expressed our opinion of the coal gas accumulation theory very clearly.

Possibly had we not referred to the Glasgow case, the first explanation would have been accepted as the correct one, as

it appeared in several papers without contradiction, and then it would no doubt have been cited as another case where there was positive evidence of coal gas explosion.

We have not yet unearthed a single case where there was any such positive evidence. After an explosion it is an exceedingly difficult matter to discover the real state of affairs existing before it; but, even granting Mr. Crompton's contention, he has yet to explain how the gas is ignited in a junction box; it requires something more than a red heat to effect this necessary part of a successful explosion of coal gas. Perhaps Mr. Crompton's omission of this point is merely an oversight. We shall, therefore, be glad if he will supplement his letter.

If wrong information is given, and allowed to appear in print uncontradicted, others have only themselves to blame if the information is accepted as correct.

The information supplied by Mr. Arnot, the manager of the Glasgow works, to quote his letter, was:—"This (explosion) was caused by a leakage from the gas mains, and ignited by a spark from punctured test wires." (See ELECTRICAL REVIEW, page 535, November 17th.) It was not denied by Prof. Kennedy, and, coming from the source that it did, we accepted it as absolutely true.

THE FRENCH ELMORE COMPANY.

THE report of Mr. C. J. Stewart, the Official Receiver and Provisional Liquidator of the French Elmore Company, has been issued, and will be found in another column. To quote a favourite phrase in Elmore prospectuses, the report is "a plain statement of facts," but unfortunately the facts are real facts. The Official Receiver has investigated the affairs of the company in a painstaking manner, and has simply recorded the results of his investigations.

Beginning at the beginning, he tells us that on September 4th, 1890, the Foreign and Colonial Company agreed to dispose of their French rights to Woodhouse and Rawson for £15,000 in cash, and a premium of £25,875 on shares if subscribed for by the public; five days later Woodhouse & Rawson transferred the benefit of this agreement to the Phœnix Trust Company, who appear to have promoted the French Elmore Company. This French Company paid £116,875 for rights which were sold by the Foreign and Colonial Company for £30,875. The capital was at once subscribed and allotted on September 19th and 22nd, 1890. On September 26th a contract was entered into to purchase six acres of land at Bellegarde for £5,000, with a minimum rental of £3,000 per annum for the water power. The land was not used, and is now valued in the assets at £1,000, "subject to realisation." On October 1st, 1890, M. Secrétan, "a French expert in metallurgy," was appointed manager. It was in November, 1890, that the board, "apparently upon the strength of representations made to them by M. Secrétan," resolved that works should be started upon a much larger scale; acquired 37 acres at Dives, near Havre, and entered into contracts for the erection of works there. In order to meet the increased outlay they borrowed £50,000 from the Foreign and Colonial Elmore Company, on 6 per cent. debentures. The cost of the works largely exceeded the original estimate, and on April 22nd, 1892, it was decided to increase the capital to the extent of £200,000 in preference shares, but only £45,032 was issued. "The company has from time to time borrowed considerable sums of money," mostly from the Foreign and Colonial Company, to which concern, on April 2nd, it mortgaged the whole of its property for the sum of £95,000, of which £50,000 was declared to be held in trust for the holders of existing debenture stock. On February 20th, 1893, the directors were empowered to issue new debenture stock to the amount of £100,000, and subscribers to this issue are the most fortunate of all Elmore stockholders, for it was stated in the circular that unless £30,000 should be subscribed for within two months, no allotment would be made. £8,533 was applied for, on which £2,747 8s. was paid, placed to a separate account, and retained by the undertakers under an injunction of the High Court. "The applicants for the stock are apparently entitled to a return of the moneys." We congratulate them on their exceptional position. The whole of the company's resources having been exhausted in connection with the establishment of the works, it was unable to meet its debenture interest, and a receiver was appointed on March 28th, 1893, voluntary liquidation was decided on at a meeting held in May, 1893, and at the same time an agreement was approved for the sale of the undertaking to M. Secrétan, who is to form a new company, pay to the receiver £8,000 in cash, and founders' shares, and debentures of the estimated value of £65,000, "subject to realisation." "The sale is now in course of completion." "The failure of the company is attributed by the secretary to the fact that the works were undertaken on too large a scale in proportion to the capital. It was intended to raise more capital later when the merits of the Elmore copper process had been proved, but this had not been done by the time the additional capital was required, and consequently the preferential shares were not subscribed for to the extent that had been hoped."

This is but a brief outline of the record of one member of the Elmore group. We must wait until an official investigation has taken place into the affairs of the four other companies, before we can learn the total losses, and be made acquainted with the steps which have led to them. We do not need to be made acquainted with the causes of them. As our readers well know, those causes were apparent to us before the losses were incurred. We did our best to prevent them, but unhappily we were not successful, and it is not now our intention to go over old ground, except so far as may be necessary to fix responsibility somewhere. It will have been seen that the capital was allotted on September 19th and 22nd, 1890. We do not doubt that the payments for the patent rights were promptly made, probably being completed before the appearance of our first article on October 3rd, 1890. But the works had not then been begun. In order that our investigations might produce some useful result, we urged directors, shareholders, and all concerned, to await practical results in one factory before starting others. We said:—

> It is too late to stop the transfer of cash from the pockets of the public to those of the promoters . . . . but there is one direction in which good money may be prevented being thrown after bad, and we earnestly press it upon the consideration of Elmore shareholders. It is a distressing incident in this process of company manufacture that sites have to be selected (and paid for), factories built and

machinery purchased, staff engaged and wages paid. We cannot too often reiterate that there is no proof of the commercial value of the process. If there were such proof, it is extremely unlikely that there is work enough for a tube factory and a wire factory in England and factories elsewhere in every country in the world. We will confine ourselves to saying that the *possible* waste of money in this direction is a sad feature of the business.

On October 31st, 1890, we repeated our advice to the subsidiary companies. We said:—

Keep the money you have in hand, and don't proceed with the work set out for you until the parent company has shown that there is a commercial success in the Elmore process. There is nothing unreasonable in this. All that will be lost is time, and that can be made up with the good start which the experience of the parent company will give you.

Had our advice been followed the sum of £161,279 13s. 7d. would have been saved in respect to the French Company alone, but the persons responsible preferred to disregard our arguments, and proceed with the works.

The directors of the French Company were paid about £3,000 by the shareholders of that company to watch over their interests and conduct their business. Did the directors, or whoever may have been the responsible persons, exercise reasonable judgment in carrying out their duties? Let us take the reason assigned by the secretary for the failure of the company. It was due to the works being undertaken on too large a scale in proportion to the capital. And why were the works undertaken on so large a scale? "Apparently upon the strength of representations made to them (the directors) by M. Secrétan," says the Official Liquidator. The representations of M. Secrétan were in the form of a report, which was sent to us for publication, and appeared on page 664 of our issue of November 28th, 1890. It was a farrago of nonsense, and would have been thrown into the waste paper basket by any body of business men. Of it we said, in the same issue (p. 638), "Had the directors not acted upon the recommendations of such a document, they would have had so much the less to answer for."

It might very truly be said that any criticisms of that report now would simply be the expression of wisdom after the event, but our words stand as indicating the impression formed immediately on the publication of the report. We reproduce them now as indirect evidence on the question whether reasonable judgment was exercised by those who ought to have exercised it. The responsibility has certainly to be shared to some extent by the shareholders who assented to the carrying on of the works upon the plausible representations made to them.

We are obliged to recall our endeavours to prevent losses by the Elmore process, our exposure of the plausible representations made to the shareholders, and our intention that some result useful to the public should ensue if possible. The only result possible now is to centre a responsibility somewhere. So far as payments for patents go, there is nothing very unusual in the Elmore Companies. The payments of large sums by companies for patents or businesses of doubtful value is an every-day occurrence. In the opinions of some individuals, it is for such a purpose that our company laws exist. The special feature about the Elmore Companies is the one that we drew attention to when we first discussed them—the waste of money on works. It was this we did our utmost to prevent, but without avail. We have now only to ask why this waste went on? Was it because the directors of each company were fully persuaded of the value of the process, and the probable profitable nature of the works undertaken? Was it because they were anxious to make-believe that they believed it, even if they did not believe it, by way of justifying the payments for the patents? Or was it because the construction of the works was a "part of the game" of speculation in which the promoters and others had indulged; a game which was perhaps unfinished on the floating of the companies, but needed subsequent dealings to complete, and which could only be completed by giving to the "revolution" an appearance of genuineness by undertaking large works? We can only propound questions. We cannot answer them. But, as bearing upon the last question, we may allude to the fact that between the price at which the French rights were sold to Woodhouse & Rawson, and the price at which they were purchased by the French Company from the Phœnix Trust, there is a difference of £76,000 cash. Allowing the odd £6,000 as an ample amount for the expenses attending the promotion of the company, and there remains £70,000 net profit in cash. How this was divided between Woodhouse and Rawson and the Phœnix Trust we do not know. But we do know that Woodhouse & Rawson are in liquidation, with an unpromising outlook for their creditors, and that amongst the assets of the French Company is an indebtedness of £900 by the Phœnix Trust, which asset is returned as "doubtful." We suppose there is no doubt money has been lost. The difficulty is to find who is the better for it. Probably this cannot be ascertained until the affairs of all the Elmore companies have been enquired into and reported upon, as Mr. Stewart has reported upon the affairs of the French Company. Every effort will be made to avoid such enquiry, of course, but we think the shareholders would be well advised to encourage liquidation under the supervision of the Court, if only with this object in view. Whether such investigation take place or not, we hope the lesson of the Elmore Companies will not be lost upon those who aim at a reform of our Company laws. In ordinary affairs there is a responsibility for culpable negligence as well as for wilful acts. A similar responsibility should exist in Company law, or, at any rate, it should not be possible for such a scandal as the Elmore Companies exhibit to exist without the responsibility being fixed somewhere. To point such a moral is all the use we see at present for Elmore Companies. We hope such a public utility will be a sufficient recompense to the shareholders for their personal losses.

Engineers and their Students.

THE necessity of taking into court such cases as that of Manville *v.* Gramshaw is very much to be regretted. There are observances connected with a premium apprenticeship irrespective of a stamped or unstamped agreement that ought to be religiously respected both by the teacher and by the pupil. A jury is not the best tribunal to determine whether a consulting engineer has failed to give a pupil sufficient tuition, or whether a pupil is justified in leaving his preceptor by reason of the lack of instruction. These are questions that could be answered only by men having a knowledge of genuine engineering instruction.

Manville *v.* Gramshaw.

LEAVING, however, the general question for the moment, it will be useful and interesting to consider this particular case of Manville *v.* Gramshaw. From the report which appears on

another page, it will be seen that Mr. Manville sued for the recovery of balance of premium. In 1890 Mr. Gramshaw, jun., became a pupil of Mr. Manville, who was at that time managing director of the Electrical Engineering Corporation. In January, 1891, however, the Corporation was burned out of existence, and the youth was drafted into the new Dublin Central Station, for the purpose of finishing his education. Mr. Manville gave this as evidence; he also added, that is, if our report is accurate, that young Gramshaw left in a few months and took a situation as wireman at £1; this speaks well for the training. The defence was that nothing was explained at Dublin. There are a few facts in connection with the Dublin Central Station that do not seem to have been put forward. It was on August 4th, 1891, seven months after the fire at West Drayton, that young Gramshaw went to Dublin; he left in the following May, having been there eight months. Now it must be pointed out that the contract for the electrical machinery was not signed until September, 1891; it was nearly twelve months after this when the station was finished.

The Pupil at the Central Station.

The foregoing facts are important, because they show that Gramshaw was at the station when it was absolutely impossible for him to learn anything. One does not pay 200 guineas to watch the unloading and the putting into position of electrical plant, besides, who at such a time can give instruction to a pupil. The proper place for so young a student as Gramshaw, that is, young in experience, was in the workshops. What on earth could he be expected to know of electrical machinery after spending a few months at West Drayton, and then completing his education by watching the installing of boilers, engines, and the digging of trenches.

A Strange Verdict.

The plaintiff cannot be congratulated on his victory. The surprising thing is not that the defendant refused to pay the premium, but that a jury should assist Mr. Manville in his efforts to obtain the balance of it. It may be said that if young Gramshaw had not taken himself off he might have been taught the profession of electrical engineering; we are rather inclined to think that the waste of time which unquestionably took place was distasteful to him, and availing himself of the instruction which he had received from Mr. Manville, he turned his knowledge into a lucrative channel and became a wireman at £1 per week.

Self-Induction as a Remedy for Static Discharge.

In articles in the *Electrical Engineer*, of America, the question of self-induction as a remedy for static discharge in telegraph cables is discussed. There appears to be a somewhat general opinion, an opinion which has existed for some time past, that a material advantage, as regards speed of signalling, would be gained by the employment of a cable of low specific insulation resistance or the adoption of a series of leaks along the length of the cable. In spite of all the opinions expressed on the subject, there is still a very indefinite light thrown upon the point. No precise data are given in any case where an advantage is said to be gained when the insulation of a line is low; we are simply told that "I have found that messages could be sent with much greater ease in wet than in fine weather," or something equally indefinite and unsatisfactory. In many cases the conditions of working have been such as to make it very doubtful whether the "improved" working has not been due to some cause in no way connected with low insulation. It seems a pity that those who have had experience cannot give numerical values and definite statements with reference to the subject. Again, how is it that those who have access to artificial cables cannot make a simple experiment which would certainly clear the ground? Artificial cables equivalent to a length of 1,000 or 2,000 miles are not very great rareties, and seeing the importance of the thing, why could not the experiment be made of putting on to such a cable, say 10 leaks of 10,000 ohms each, and see what effect is produced on the signalling? If there were less theorising and more experiment the mystery (if it may be called such) might soon be cleared up.

The Educational Influence of the Alternating Current Theory.

The progress of our knowledge of electricity during the last few years owes much to the "method of instantaneous contacts" discovered by Joubert in 1880, and extensively applied by him and others to the study of the "time-element." Its application to the periodic phenomena of the alternating current circuit has been most fruitful of results, and, moreover, has conferred an attractiveness to these important matters which, owing to their complexity they would not otherwise have possessed. Prof. E. L. Nichols has recently published an address delivered before the American Association for the Advancement of Science in which the history of researches on the phenomena of the time-infinitesimal is clearly and instructively set out. Incidentally, when describing the results which have been won from the unknown by Joubert's method, Prof. Nichols remarks that the difficult nature of the alternate current theory has proved a benefit to electrical engineers in that it has forced them to increased mathematical proficiency and to more rigorous thinking. What the problems of submarine telegraphy did for the English electricians who served their apprenticeships during the early days of the cable-laying industry, compelling the development of those sturdy qualities which have been so highly serviceable in every branch of electrical progress since, the intricacy of alternate current practice is unquestionably doing for the younger school of electrical engineers which is growing up to-day. The professor thinks that the difficulties which have still to be met and overcome in the study of alternating currents will have an excellent influence upon the manner in which the problems of the future will be approached.

Some Electric Furnace Phenomena.

Some interesting experiments have recently been carried out by Mons. J. Violle on the radiation of different refractory substances heated in the new electric furnace, a description of which has appeared in the Electrical Review, No. 796, p. 214. A doubt having been thrown on Rosetti's statement that there occurs in the arc a temperature notably higher than that of the positive carbon, Mons. Violle undertook to investigate the question. He introduced into the arc a fine rod of carbon, and observed that it became rapidly worn away, showing a hollow on the side facing the cathode, and being covered with a powdery deposit on that side opposite to the anode. This phenomena recalls what takes place in a galvanoplastic bath when a metallic rod is immersed in it, and it is evident that the law of Grotthus applies to the case. Mons. Violle has made some well known investigations of the extremities of the positive carbon, and he applied the methods used to the examination of the cavity which formed on the side of the carbon rod which was turned towards the cathode, with the result that he recognised the same appearance and lustre as he had previously found on the positive carbon. In other experiments, coke, lime, magnesia, zirconia, and chromic oxide were investigated, and if was found that in the electric furnace all these substances which, chemically speaking, are so different, present exactly the same brilliance and act equally upon the eye and a photographic plate. Thus, in an enclosure, all parts of which are at an equal temperature, all these substances are in an equilibrium of radiation according to Kirchoff's law. A paper by Mons. Violle, describing these experiments, was recently presented to the Paris Academy of Science.

ELECTRIC LIGHT AT CAPE TOWN.

AFTER the authorities of Cape Town had signed an agreement with the firm of Siemens & Halske, of Berlin, for the erection of an electrical central station on municipal account, and had entrusted the firm with the supply and erection of the electrical part of the installation, the same firm undertook the erection of the motive power plant, so that now all the supplies and constructions for this extensive installation will be effected by the same firm, with the exception of the buildings and the pressure leads of about 2,000 metres in length.

Referring again to our former note, the installation in question will consist of a sub-station of accumulators, situate outside the city, from which the distribution of current will be effected over the entire city on the five-lead system.

The arrangement of the primary station is such that each of the two dynamos (type F., of the firm Siemens and Halske) can be directly connected both with a turbine and with a steam engine, so that, at pleasure, either the turbines or the steam engines can supply the motive power.

The turbines to be supplied by the firm, F. M. Voith, of Heidenheim, are of the vertical type with partial admission, and each of 200 H.P., at 250 revolutions per minute. The water introduced by a pipe, 2,000 metres in length, has an available fall of 194 metres. The two steam engines, to be set up at the primary stations, are to be supplied by the firm, G. Kuhn, of Stuttgart-Berg. These will be of the compound-condensing type with vertical cylinders, working at a pressure of 100 lbs. at 250 revolutions per minute, giving 200 H.P. The steam will be supplied by two circulating tubular boilers, each having 150 square metres heating surface. These boilers are constructed by Simonis & Lenz, of Sachsenhausen, near Frankfurt.

The preliminary works for the entire installation are so far advanced, that by the middle of February next, the works for mounting the machinery and laying down the leads can be taken in hand. All the works are being pushed on, so that before the expiry of the next year the installation will be in full working order.

SAFETY SYSTEM OF ELECTRIC WIRING.

IN regard to the letters reproduced in our columns last week, Mr. C. J. Kintner writes to the New York *Electrical Engineer* as follows:—"Referring to Mr. Caryl D. Haskins's communication in the *Engineer* of November 15th touching my safety system of wiring, I beg to say that all that Ferranti had done in the way of concentric wiring was thoroughly familiar to me when I first gave attention to this matter, which was soon after the first description of the Ferranti system. Mr. Haskins may not be aware of the fact that the concentric system of wiring is, broadly, much older than Ferranti's time, having been fully disclosed in a patent granted Mr. Edison on May 4th, 1880, and numbered 227,228.

"A concentric system of conductors was also contemplated by another pioneer in the art, namely, Mr. William Edward Sawyer, as is disclosed in his work on "Electric Lighting," on pages 156 and 157, published by Van Nostrand in New York, in 1881. In the systems of Edison, Sawyer, and Ferranti, however, the interior conductors were permanently secured in place either in the nature of a concentric cable or an interior conductor insulated by permanent insulation connected to the walls of exterior tubing. My system contemplates at all times the ready removal of the interior conductor and my patents, Nos. 426,127 of April 22nd, 1820, and 473,932 of May 3rd, 1892, are limited to this extent.

"The Ferranti system of cables was found to be impracticable for the reason that when the insulation was ruptured it necessitated the taking up of the entire cable for repairs. With my system the exterior or tubular conductor is a fixture, while the interior conductor or conductors is, or are, always removable—a very material difference, as will be appreciated by those who have to do the repairing of concentric cables. In short, my system contemplates an accessible concentric system from the lights to the commutator brushes, thereby permitting the removal of the interior conductor or conductors in sections for repairs or the substitution of one interior conductor for another where a number of them are so enclosed by an exterior conducting tube or conduit.

"With my system, I may add, it is entirely probable that what is known as the Ferranti effect would not be present if the exterior tube be of sufficient interior diameter and the interior conductor be located in the axial centre of the tube and surrounded by dry air.

"I may add also for the information of Mr. Charles Wirt, whose letter of criticism upon my system is printed on page 438 of the same issue of the *Engineer*, that my date of invention broadly anticipates what is known as the Andrews system and that a concentric system of wiring may be constructed cheaper than a two wire system where the wires are surrounded by protecting casings.

"CHARLES J. KINTNER.

"New York, *Nov. 16th*, 1893."

CANDLE-POWER OF SEARCH LIGHTS.*

BY CHAS. P. STEINMETZ.

I AM very sorry to see from Mr. Hering's remarks on my note on search lights that he has considered it as personal. Far from having this intention, my remarks coincide with Mr. Hering's, and they are meant to be used to correct some misunderstandings on the matter under discussion which are made very frequently; and that quite curious views exist on this subject has in the meantime been proved again conclusively by a collection of mistakes in the editorial remarks of the London *Electrician*.

Referring to the law of inverse squares, the only qualification required is, as stated in the closing sentence of my note, the same as that in photometric tests of any source of light, as an incandescent lamp, viz., that the distance from the light must be large enough to make the diameter of the light negligible against the distance.

In the photometry of incandescent lamps a distance of one metre is considered more than necessary to apply the law of inverse squares. This is 25 times the height of the flame of a standard lamp. Hence, with a reflector of 5 feet diameter, a distance of 125 feet from the reflector is sufficient to permit the application of the law of inverse squares. Usually larger distances, as 1,000 to 5,000 feet, are preferred for convenience. In this distance the law of inverse squares holds true, and the atmospheric absorption in clear nights is still negligible. In the diagram shown in Mr. Hering's note this condition is not fulfilled, and therefore the inverse square law does not apply. The point, P, shown there as apparent centre of light behind the reflector, does not exist, as the attached diagrams will show.

FIGS. 1 AND 2.

In fig. 1 the source of light is a mathematical point in coincidence with the focus, F, and in this case the light leaves the reflector as a beam of parallel rays, and the rays appear to come from a point of infinite candle-power at infinite distance, *i.e.*, the term candle-power becomes meaningless.

In fig. 2 the source of light is point C, inside of the focus F, and the rays leave the reflector divergent, exactly like coming from point P behind the reflector.

In fig. 3 the source of light is the point, C, outside of the focus, F, and the reflected rays converge towards a point,

* New York *Electrical World*.

P, in front of the reflector, so that at a distance the light seems to emanate from a point, P, in front of the reflector.

By f = focal distance, it is approximately:

$$f^2 = \overline{FC} \times \overline{FP}.$$

These figures 1 to 3 are of theoretical interest only, and cannot be realised in practice, since the source of light is not a point, but a finite area, the crater of the arc. In this case, shown in fig. 4, each point of the reflector surface is the centre of a pencil of divergent rays, and the rays leave the

FIGS. 3 AND 4.

reflector with the natural dispersion, which, however, is not a true divergence, like in fig 2, and there exists no point where the rays converge, or seem to emanate from, but every point of the reflector acts like a source of light or like a point of the crater.

The appearance of the beam of light in a greater distance will be similar to fig. 5, *i.e.*, the beam consists of a cone, *a*, in which every point receives light from all the points of the reflector surface so that for the cone, *a*, the reflector acts like a crater of the area of the reflector. This cone, *a*, is surrounded by a penumbra, *b*, which

FIG. 5.

receives light only from a part of the reflector, and where the intensity gradually decreases from the full brilliancy of the interior cone to the outside darkness. Further, there exists a cone, *c*, receiving light only from a part of the reflector also, but in such a way that in *c* the surface intensity is approximately constant, similar and corresponding to the beam in fig. 1. In *a*, however, the intensity varies proportionally to the square of the distance from the reflector.

As diameter of the beam of light it is customary to consider the diameter from centre of penumbra to centre of penumbra, as shown in dotted lines in fig. 5.

Superposed upon this natural and unavoidable dispersion of the beam due to the finite extension of the crater can be a further dispersion by moving the lamp out of the focus, as in figs. 2 and 3, and this is done where dispersed light is desired. With the lamp in the focus, however, as in fig. 4, the reflector can, at all points within the cone *a*, fig. 5, be replaced by a crater of the size of the reflector, and the inverse square law applied.

Obviously the distinction between central cone *a* and penumbra *b* is in practice by no means as sharply defined as shown in fig. 5, in consequence of the unavoidably irregularity of all human apparatus; and, furthermore, in consequence of a small variation of the angle of dispersion for different points of the reflector surface, as shown in fig. 4.

I hope that these remarks will be sufficient to clear up the misunderstanding on the question of search lighting, which now very widely exists.

I enclose a copy of a letter to the London *Electrician*, correcting the mistakes contained in its recent editorial, which was reprinted in your last issue.

To the Editor of the London "Electrician":

Referring to the editorial remarks on the candle-power of search lights, I am very sorry that you should have so thoroughly misunderstood the meaning of my letter as to assume that I referred to the surface illumination produced by the beam of light. I precisely meant the candle-power of the search light as measured in the same way as is done with any incandescent lamp; for instance by photometric tests at a distance sufficiently large to make the diameter of the light negligible against the distance, so as to make the law of inverse squares applicable.

I think I can trace the source of this error in your editorial remark to a mistake as to the nature of the rays emitted by the light, an error which, by the way, is frequently made. You seem to assume that the rays of the search light are naturally parallel, and that what there is of divergence is due to irregularities, &c. This would, indeed, be true if the light-giving source were a mathematical point in coincidence with the focus. Since, however, the crater of the arc is not a point but an area, there exists a true divergence in the rays of the search light, and the rays issue from the reflector not mainly in one direction only as a parallel beam as you state in your remark, but about uniformly in all directions within a small spherical angle, the angle of divergence of the beam. The result hereof is that the diameter of the beam—except in the immediate neighbourhood of the reflector—is proportional to the distance from the reflector. Hence, the illuminating power is inversely proportional to the square of this distance, and the search light acts exactly similar to an ordinary arc lamp with a screen with a round small hole in front of the lamp, which permits only a beam of small angular diameter to pass, but by no means a beam of parallel rays.

It is certainly not possible in the short space of a letter to give a complete treatise on the search light, correcting, for instance, the further error you make in your editorial, that only the solid angle subtended by the reflector needs to be considered, and that the large size of the reflector is therefore only for the purpose of avoiding shadows, &c.

I may refer you to a short treatise on this question by Mr. F. Nerz, in your own paper, the *Electrician*, where I hope you will find all the explanation necessary to understand the fact that the photometrically observed candle-powers are really of such magnitudes.

CHARLES P. STEINMETZ.

November 7th, 1893.

THE NEW SYSTEM OF ALTERNATING CURRENT AND TRANSFORMER DISTRIBUTION.

BY RANKIN KENNEDY.

V.

CENTRAL STATIONS AND SUB-STATIONS.

BY employing continuous current dynamos fitted with alternating current collecting rings, we are enabled to not only obtain either kind of current, but are able also to charge accumulators and to discharge them either into the continuous current mains or into the alternating current circuits, so that storage can be utilised to the very greatest extent; and, further, a very great advantage comes with the use of storage with the high-pressure alternating current supply. We can charge at low-pressure and discharge at high-pressure, the pressure being raised by the step-up transformers. The curves given by these machines are true sine curves, the construction is simple, and we know exactly the efficiency and everything else about continuous current dynamos. High-pressure generators of great size and power are not necessary; the money spent on oil circulating devices, on insulation, and on increased care is far more profitably spent on step-up transformers.

Now a great deal depends on the form of curve given by an alternator. The curve which we find gives the best all-round results is the true sine curve; any other curve becomes deformed in transforming, and any other curve introduces difficulties in parallel running and also into the working of multiphase motors. This subject is one requiring more attention than it has hitherto received, but we cannot stop here to investigate it, but may say that some machines give true sine curves, for instance, Kapp's alternator. Flat coil machines, whether of drum or disc form or with or without iron armatures, rarely give true sine curves, although some of them can be constructed to approach a proper curve.

In the universal dynamo to be used for the new system, we have a steady rising and falling sine curve, no violent jerking of coils out of or into strong magnetic fields such as we have in all so-called alternators. The shock and sound caused by these violent jerks in alternators of any size are quite apparent to the ear a long distance from these alternators. The universal dynamo is comparatively silent and that is a very significant fact.

Before leaving this subject of the universal dynamo, I may venture to express my opinion that this kind of machine would have given the best results if used in the Niagara Falls generating station.

Referring to fig. 10, we have the station in diagram; R is the dynamo armature, with the usual commutator and brushes, N, S, are the field poles here taken as only one pair. *a*, *b*, *c*, *d*. are the four collecting rings with connections taken from four plates at right angles from each other on the commutator, and *a'*, *b'*, *c'*, *d'*, are the four conductors from these collecting rings carrying the two alternating currents. E and F are the two continuous current mains; *w*, *x*, *y*, *z*, are the two high-pressure transmission mains or feeders going out to a sub-station; *s*, *t*, *u*, *v*, are the low-pressure alternating mains for near by supplies, in this diagram we have a

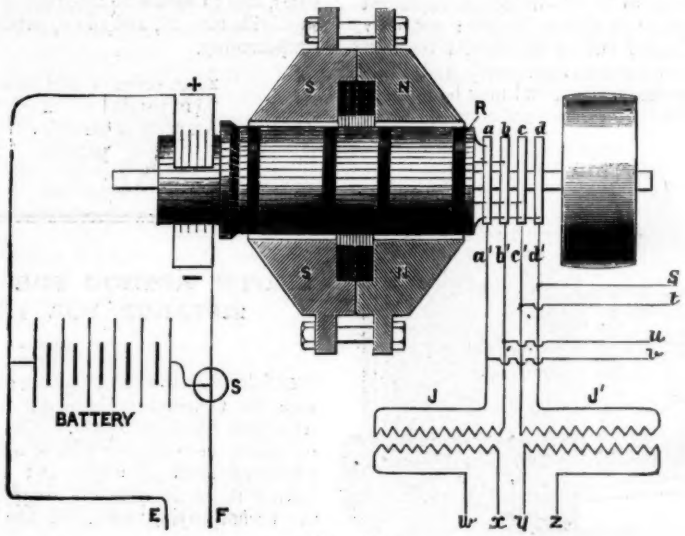


FIG. 10.

skeleton outline of the new generating station. Now, suppose the dynamo driven by power, we can send out the continuous current from the brushes through E, F, and while doing so may at the same time charge the storage battery. We can switch the main off at S' and charge only from the brushes, and at S' we can switch off battery and feed mains only.

From the alternating rings we can be at same time feeding low pressure alternating circuits, *s*, *t*, *u*, *v*, and high pressure alternating circuits, *w*, *x*, *y*, *z*, through the step-up transformers, J, J'.

Now suppose the dynamo disconnected from the engine or power, and the battery switched on to both E, F and dynamo, the dynamo will run as a motor driven by the battery current and still we can supply all our circuits just as before, only the energy will be drawn for all of them from the storage battery.

The continuous current mains, E, F, will be supplied direct from battery, the alternating circuits will be supplied through the dynamo, thus we can employ storage for all our circuits at the very place where storage ought to be, namely at the generating station; to feed the alternating circuits the battery current enters by the brushes on the ordinary commutator and, as can easily be followed in fig. 11, flows into the connections, *a*, *b*, *c*, *d*, to the collecting rings, here shown concentric. In the position shown in the fig. 11, *c d* are receiving the full current direct at full power, as the connections are immediately under the brushes, while *a*, *b*, are at this moment neutral and receiving no current. As the armature revolves, *a*, *b* begins to receive current, and *c*, *d* to lose in current until a position is reached where the brushes are midway between the two pairs, at which position both currents are equal, then *a*, *b* comes under the brushes and their current rises to a maximum, *c*, *d* being now at a minimum. Thus we get the two currents always in quadrature, the one is at a maximum when the other is a minimum; this is the action whether the dynamo is driven as a motor by a current entering the brushes, or whether the dynamo is working as a dynamo driven by an engine, as can be readily seen.

Now, if we consider the diagram 10 to represent a sub-station, we begin at the high pressure feeders, *w*, *x*, *y*, *z*, and consider these as the distant ends; on the currents arriving at J, J', they are at once reduced to 120 volts by these transformers. Passing on, they then feed the low pressure alternating circuits, *s*, *t*, *u*, *v*, leading from the sub-station to the consumers, then through *a'*, *b'*, *c'*, *d'*, they pass on into the dynamo and drive it as a two-phase motor at full speed. When thus driven the dynamo gives out a continuous current from brushes, +, —, and feeds the continuous current mains, E, F, and, if desired, also charges the storage battery.

These sub-stations are simply small models of the generating station, only without the boilers and engines, or other prime mover.

It will now be seen that the whole system pivots on this kind of universal dynamo, that is so only in so far as the generating station is concerned. This universal dynamo, as I have called it, and shall continue to call it in all future references, is not essential at the sub-stations.

At some sub-stations only two or one alternating currents would be required. In such sub-stations only two step-down transformers would be required. Then again there are at least four different methods of converting quadrature currents into continuous currents; these are new methods, and I shall not be able to describe the best one just at present, on account of

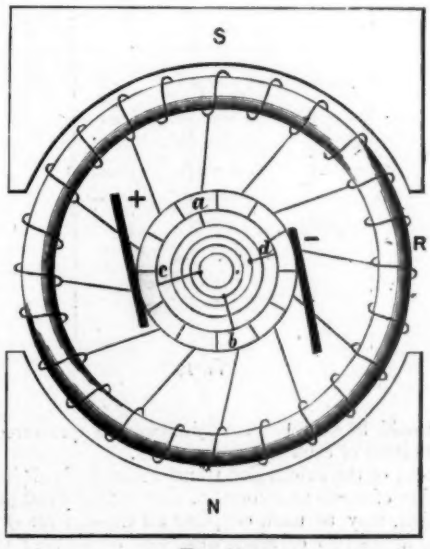


FIG. 11.

patents, but will do so before the close of this series; the other three I shall describe at once.

These diagrams can be used to explain the whole of the

central and sub-station arrangements on the new system, and any readers wishing for an explanation on any points which are not made clear, will obtain every information if they mention them.

Before leaving the consideration of the central station apparatus we must consider the step-up transformers.

The use of safe, easily insulated, and cheap low pressure generators, with step-up transformers, was first advocated in the face of not a little ridicule, by the author in his original articles in these columns in 1886 and 1887; since then, the idea has become fashionable and is now considered the correct thing.

Step-up transformers ought to be sub-divided, as explained and illustrated by the author at that early date; not only must the copper be sub-divided but so also should the iron magnetic circuits. The transformers then made and illustrated are still the best for the purpose, and may be referred to again in figure 12, which shows the complete transformer

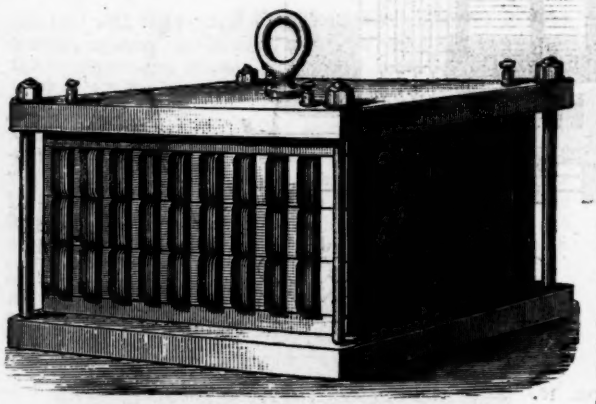


FIG. 12.

with 27 divisions. Fig. 13 is a diagram of this transformer showing the short paths of the magnetic flux.

With this construction the amount of iron is reduced to a minimum in large transformers; the secondaries are coupled in parallel and the primaries in series for a step-down transformer, and *vice versâ* for a step-up transformer.

The insulation of such a transformer stands much less chance of breaking down. Supposing 10,000 volts on the primaries or secondaries and 100 divisions in the transformer,

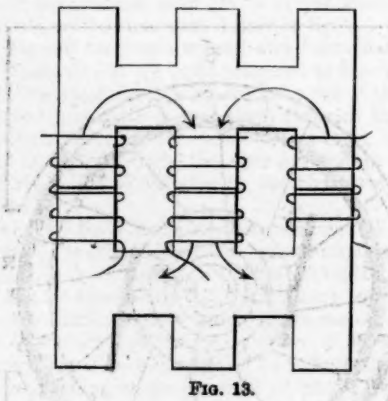


FIG. 13.

there would be only 100 volts difference of pressure between the terminals of each coil in the series.

Instead of the subdivided transformers built all in a piece, a number of small transformers, each carefully insulated from the other, may be used, coupling all the one set of coils in parallel across two omnibus wires and connecting the other set in series; this is, perhaps, the best way to deal with extra high pressures.

It may be said that although by this means the risk of break down in the high pressure coils is minimised, that the full pressure is still within striking distance of the low pressure coils, that is so; but it is comparatively easy to make good insulation between the primary and secondary coils, in fact, an air space may be left between them.

The primary and secondary coils are made alike in number of turns and in size of wire. Thus, in the above instance of 10,000 volts, we reduce to 100 volts, that is, 100 to 1 is the ratio of transforming, so that we employ 100 divisions each of 100 volts, so that by coupling the one set of coils in series we get n ampères at 10,000 volts, and by coupling the other set of coils in parallel, we get 100 n ampères at 100 volts.

Supposing the pressure to be 2,500 volts (a common pressure), and to reduce to 100, that is 25 to 1 in ratio, we would subdivide into 25, and so on, subdividing in the ratios of our transforming.

25 in series of	100 volts each	=	2,500
25 in parallel	„	=	100
Ampères in series ...	...	=	n
„ parallel	...	=	25 n

SIMPLE METHOD FOR CORRECTING RESISTANCE FOR TEMPERATURE.

THE following method of correcting the resistance of copper wire for temperature is given by Mr. C. Hering in the American *Electrical World*. The method applies when the resistance of a copper wire at a given temperature is to be calculated from its length and diameter. Instead of correcting it for temperature simply, use the value of K, from the accompanying table, for the nearest temperature, and calculate the resistance from the formula $R = K \frac{L}{d^2}$. In this formula L is the length in feet, d the diameter in mils (or d^2 the cross-section in circular mils), and K the mil-foot specific resistance for that temperature. As will be seen, the table has been so prepared that the value of K contains only two digits, one of which is unity, thus making the calculation a very simple one.

The table is based on the Matthiessen standard suggested by the committee of the American Institute of Electrical Engineers, namely, 9·612 legal ohms for one mil-foot at 0° C.

K	Temp. in Fah. degrees.	Temp. in Cent. degrees.	K	Temp. in Fah. degrees.	Temp. in Cent. degrees.
10·0	50·5	10·3	10·8	86·9	30·5
10·1	55·2	12·9	10·9	91·3	33·0
10·2	59·8	15·4	11·0	95·7	35·4
10·3	64·4	18·0	11·1	100·0	37·8
10·4	69·0	20·5	11·2	104·4	40·2
10·5	73·5	23·1	11·3	108·6	42·6
10·6	78·0	25·6	11·4	112·9	45·0
10·7	82·5	28·0	11·5	117·1	47·3

DEATH OF PROF. TYNDALL.

THE death of Prof. Tyndall, which took place at Haslemere, on Monday evening last, was somewhat unexpected. He had been in a weak state for some time past, but it was not conjectured that the end was so near.

It is impossible to do justice to the memory of the great scientist in the space of an obituary notice; still there are points in his life which we feel ought to be mentioned in these pages. It cannot be said that Tyndall distinguished himself in pure electrical science; that was because, apart from other subjects, it apparently possessed no great interest for him. Where it touched directly upon his researches he considered it carefully, and where it aided his investigations

into the phenomena of light and heat, he gladly availed himself of it. Apart from his scientific attainments his career has been an eventful one. He was born at Leighton Bridge, Ireland, in 1820, in humble circumstances. His father, though poor, contrived to give him a fairly good education; at 19 years of age he joined the Ordnance Survey, and five years later became connected with some Manchester engineering works. Then he became a teacher at Queenswood College, and afterwards studied chemistry under Bunsen at Marburg. While a student at Marburg he translated the memoirs of Clausius on "The Moving Force of Heat." In 1851 Tyndall went from Marburg to Berlin, to prosecute his researches in the laboratory of Prof. Magnus. While at Marburg, along with Dr. Knoblauch, he devoted much time to researches on magnetism, in which he achieved some important results. His enquiries were not based so much on the desire to clear up and explain the phenomena of magnetism, as to discover the effect of magnetism and diamagnetism on molecular arrangement. He published jointly with Prof. Knoblauch, in 1850, a memoir on this subject. These researches were afterwards continued in the laboratory of the Royal Institution, and the results were published in 1888 in a volume entitled "Diamagnetism and Magne-crystallic Action." Faraday seems to have exercised a marked influence on his life, for his scientific investigations, and the beauty and serenity of his inner life were, to a great extent, based on the example set by Faraday. He first became acquainted with Faraday in 1850, and three years later was appointed, at the suggestion of Faraday, Professor of Natural Philosophy of the Royal Institution. Tyndall's admiration and friendship for Faraday continued throughout the life of the great savant, and shortly after Faraday's death, he wrote an appreciative work on "Faraday as a Discoverer." We can only catalogue briefly a few of his most important works. In 1859 Tyndall began his researches in radiant heat, and published numerous papers on the subject in the *Philosophical Transactions*. "Heat, Considered as a Mode of Motion," probably his most famous book, was published in 1863. Then followed volumes on "Sound and Light," "Notes on Electricity," and "Notes on Light." He delivered in the seventies, at the Royal Institution, a course of lectures on electricity; they were adapted to a juvenile audience, but the manner of treatment was so lucid, that they attracted much notice. As a popular lecturer he had scarcely a rival; his lectures were fascinating, but not at the expense of scientific facts. For several years Tyndall acted as scientific adviser to the Board of Trade and the Lighthouse Authorities, positions which he resigned in 1883, consequent on a quarrel with Mr. Chamberlain. His independence of spirit often brought him in conflict with the so-called great ones on the land; but it is satisfactory to know that he always remained a man, and never truckled either to First and Last Lords of the Admiralty, or self-seeking politicians. There is an instance of his independence worth quoting. Among public appointments held by Tyndall was that of Examiner under the Council for Military Education; he considered that his department did not receive fair play at the hands of the Council. He said so in the *Times*, and the bigwigs of the Council reprimanded him. This reprimand was replied to with spirit, and Tyndall awaited his dismissal. The Council, however, took the reply in good part, and, instead of dismissing him, sent a letter which permitted him to retain both his post and his self-respect. This is a characteristic incident of the uncompromising attitude generally adopted by Tyndall towards his opponents. We cannot close this scanty record without referring to a matter in which we were lately deeply concerned. Prof. Tyndall was approached as to being a witness in our recent litigation. He was too ill, but sent us the following encouraging letter:—

Hindhead House,
Haslemere.

Gentlemen,—I would aid you if I could, for I have been often exasperated by advertisements bearing on the subjects you mention. But I have just returned to my home still so broken in health, that my standing in a witness box is quite out of the question. In all my life I never occupied this position, so that even apart from my illness the entering of a witness box would be repugnant to me.

Yours faithfully,
(Signed) JOHN TYNDALL.

The physician who attended me in my late illness was unmeasured in his denunciation of these quackeries.

THE MERITS OF STEAM, ELECTRICITY, AND WATER, FOR HOISTING-WORK.

MR. GEORGE A. GOODWIN, of London, is the author of a valuable paper on the relative merits of working hoisting machinery by steam, water, and electricity, which has recently appeared in the *Journal* of the American Civil Engineers. The author's conclusions are based on somewhat narrow grounds; so far as we can see the electric cranes at Southampton is the only instance of the working of electricity that he has enquired into. He might easily have gone a little further, and ascertained the exact cost of electricity for hoisting work at Manchester and Bradford. He might have seen no cause to alter his opinion, but had he considered these cases, one might have been more disposed to accept his figures without much question. Still the paper is interesting, and the following abstract may be found useful:—

The questions that arise, and which concern all engineers who have to select and decide on a system of power for application to a certain purpose, are:—

Which system is most economical to work, which entails the least initial outlay, and which system has the fewest disadvantages?

Before entering into the details indicated, the following postulates should be conceded.

1. That steam-worked machines are supplied with steam drawn from a centre or distributing boiler or boilers, or that each machine is supplied from a self-contained boiler. 2. That where hydraulic power is used, the water is supplied from a central pumping station and distributing plant. 3. That where electricity is used, the current is supplied, as in the hydraulic system, from a generating plant from a central station; for, obviously, if the hydraulic or electric power were generated by an engine self-contained on the machine, the conversion of the energy in the steam into hydraulic or electric energy, to be after re-converted into mechanical power, would entail considerable loss in useful effect as compared with driving direct, unless some system of storage were introduced.

STEAM.

To obtain the full advantage of steam, when used as the motive power, it is necessary, primarily, that all the machines so driven should be supplied from one or more batteries of boilers and should be regularly at work, in order that the average demand for steam should bear a high proportion to the maximum drawn off and for which the boilers are designed, so that the firing and evaporation may be as nearly as possible constant. If this condition of working does not exist, a considerable loss of efficiency must result.

By reason of the difficulty of regulating the supply and the combustion of the fuel, which naturally cannot be quickly adjusted to accord with the varying requirements, particularly if mechanical stokers are used (which are so necessary to economical firing), it follows that at times of small demand for power there will be a relative excess of steam formed going to waste through the safety valve, while during large and sudden demands there will be a deficiency; and in case of the former, all the working expenses, as well as coal and water, go on uninterruptedly, thus reducing the efficiency and raising the cost of working abnormally high.

Again, there must always be a slight continual loss by radiation along the steam pipes and boilers however well protected by some of the many non-conducting compositions, and which increases proportionally when the demand for steam is low.

One method of lessening the cost of working is by keeping the boiler output constant. The overcoming of the difficulties of storing heat energy as it is formed in excess of the supply drawn has recently been brought forward by Mr. D. Halpin, of London, and referred to by Prof. G. Forbes in his paper read before the St. Louis National Electric Light Association, on March 1st, 1893.

It is well known that when a large plant is at work, the individual units being spread over an extended area, the demand for power must fluctuate, and that the minimum and maximum loads differ very greatly from each other, the maximum load sometimes reaching from three to four times the average load. To cope with this fluctuation, it is necessary to supply motive power capable of handling the maximum demand when it arises, and which is consequently three to four times the capacity that it need be if the power were required at an even rate and of the same total amount.

The practical efficiency of this system, says the author, has yet to be proved, the great question being the regulating and ensuring of proper circulation of water, which, when the number of storage reservoirs containing it are greater than the number of the generating boilers supplying them, causes such an increase in the difficulties that on this particular point the whole success must depend. In other respects one can venture to prophesy satisfactory results.

When hoisting machinery, such as isolated cranes, lifts, &c., is used, it is necessary to economy that they should be constantly at work, or else a considerable loss must take place in the combustion of fuel during the periods of light load or small demands already alluded to.

Where a large plant, however, such as is generally used at all docks of importance, and where a large proportion of the cranes could be relied upon to be working simultaneously, steam can be economically supplied from a central battery if other and disturbing conditions do not arise, such as:—

(*a*) The difficulty of connecting the cranes to the main steam pipes, at the different points required for service, where such cranes are to be movable along, for instance, the side of a quay.

(*b*) Risks of sudden and complete stoppage of the whole of the plant, and danger to human life in case of the bursting of a main.

(*c*) The loss entailed by reason of the expense and difficulty of returning the exhaust steam to the boilers, or else allowing it to escape into the atmosphere.

The author is aware that this question of supplying steam over an

extended area has been successfully accomplished by the steam supply of New York; but here, as far as he knows, the spent steam and condensed water is caused to flow back again to the generating station, where it is no doubt easily returned to the boilers. Where, however, the steam supply is to be used for motive power purposes, it would be necessary to condense the steam at the generating station on its return, so as not to throw a back pressure on the consumer's engines, thus necessitating increased plant and working expenses. For driving shop or yard travellers, this system of central steam supply is not applicable, on account of the difficulties referred to in the way of connections of machines to steam pipes while allowing for their travelling.

With regard to efficiency, it appears from the comparison of different steam cranes and hoisting machines that about 1·1 to 1·4 lbs. of steam, on the average, are utilised in the cylinders (at 60 lbs. boiler pressure) in small and large cranes, respectively, for every horse-power of work done on the weight lifted, and taking the evaporation of water per pound of coal in the case of a central supply battery at 9 lbs., and in self-contained power machines as about 7 lbs., the figures work out as follows:—In plant supplied from central battery 7·33 lbs. of coal are required per hour per horse-power done on the weight, and in self-contained machines, 9·4 pounds.

To test the actual cost on a large practical scale, the author, through the kindness of some friends at an important coal station in London, has been enabled by a three-days' trial to determine that the cost of lifting coal from the holds of vessels lying alongside on to the wharf to be 1½d. per ton. This includes craneman's wages, cost of cranes (taking their life at 20 years), coal, oil, waste, water and repairs.

For large concrete block-setting machines, generally known as "Titans," or for yard travellers, contractors' cranes, excavators, and such tools, machines with self-contained engines and boilers would no doubt prove the most serviceable.

In steam-hoisting machinery there are, necessarily, a large number of working parts, both in the engines and the machines proper, including the various shafts, gears, clutches or cones for putting the different motions in and out of action. These not only give rise to much rattle, wear, and tear, but necessitate a heavy amount of upkeep and require the attention of an experienced driver, who also has to attend closely to the boiler firing and feeding, while undivided attention should be given to the work in progress.

Hydraulic Power.

As in the case of steam, to use this power economically it is also necessary that all the plant supplied from one central station should be regularly at work, and that the average demand for power-water should bear a high proportion to the maximum that the plant is designed for; otherwise the losses in fuel, steam, and general working expenses at periods of small demand will exist. These losses, however, can be effectually prevented in certain cases, where, instead of obtaining the pressure-water by passing it through accumulators, circumstances permit the use of a storage reservoir, placed at the required height, to give the desired pressure, and of such a capacity as to contain a supply for at least 24 hours' working. This, neglecting pipe friction, would be 1,613 feet, to give an effective pressure of 700 lbs. per square inch. In this case, under such conditions, the pumping plant would only have to be of sufficient daily capacity as the average required by the working plant spread over the 24 hours.

Where plants, however, take the form of a public service, such as exist in London, Hull, Birmingham, Liverpool, Manchester, and some of the chief cities in Australia, and where, by the multiplicity of uses to which the power is applied, the average demand in such cases becomes fairly constant during known periods, the daily consumption is proportioned somewhat as follows: From 6 to 8 a.m., when the artisan class commence working, warehouses and loading and unloading stations are the chief users; from 9 to 12, full demand takes place, by the continuance of this class of work plus that required for passenger lifts for offices, &c.; there is then a lull during the lunch or dinner hour, and from 2 till 5 or 6, when the warehouses close, there is again the full demand. After this another special requirement takes place, in the use of lifts in hotels, clubs, chambers, residential mansions, &c., giving a gradually lowering load until midnight, when the minimum takes place until 6 a.m. And so, by the use of a constant daily diagram, which can be taken and recorded, it becomes possible for the officer in charge of the central station to regulate the firing of the boilers and generation of the steam-power, and thus a fairly good efficiency and economical working of the plant can be obtained, even where the water pressure is obtained by passing it through accumulators.

Hydraulic power is peculiarly adapted for all kinds of lifting purposes, the working of presses of all types, and last, but not least, as a means of obtaining powerful jets of water for the extinction of fires.

The action of the water in the hydraulic cylinders, viz., the moving of the rams in a rectilineal direction, renders this power the most direct of all others, as all hoisting machinery has obviously to move weights straight up and down, and all rotary motion, with the constant reduction in speed, and the consequent wear on rapidly moving parts, can be dispensed with. The expression "rapidly moving" is used advisedly, as in almost all cases the prime revolving motor, to be within reasonable proportions, has to be made to work at a relatively high speed. With regard to wear of hydraulic machines, the friction of the rams in the glands is almost infinitesimal; the only parts subject to much work and abrasion are the chains or ropes, and the axles of the pulleys over which they pass. This, also, is very small, owing to their slow speed of rotation.

One great disturbing element to the proportioning of the supply of water-power to the work to be done, always more or less exists in hydraulic machinery, and is due to the fact that water is non-compressible and non-expansive, the result being that the same quantity of water is used, whether the load lifted is great or small, and in the case of hydraulic engines, that there is difficulty in regulating the strokes to the work required to be done.

In this branch of mechanical engineering, however, some success has been arrived at in overcoming these objections.

In the best designs of hydraulic cranes, when fully loaded and under favourable conditions as to working, the total efficiency is about 60 to 70 per cent., while in direct-acting hoists, that is to say, where only one ram is used, this would rise to about 80 per cent., which represents on the average about 35 lbs. or 3½ gallons of water for every horse-power of work done on the weight lifted. This referred to the consumption of coal at the central station means 4·5 to 5 lbs. per horse-power in weight lifted by the machine.

Electricity.

With regard to the use of this still mysterious agent as a motive power for lifting purposes, a fair amount of work has been done of late years, not only by manufacturing electricians, but by mechanical manufacturing engineers particularly, and the author has had the advantage of making tests with some of them. The remarks relating to the necessity of the plant being regularly at work, &c., apply to the use of electricity as well as of steam and water, for although the nature of the dynamo machine is such that the electrical output regulates itself in accordance with the demand, yet the prime mover (the boiler) still gives rise to the difficulties of regulating the fuel and steam generated. The use of secondary batteries gets over this trouble to a great extent, and they are used chiefly in connection with the public electric light installations, where continuous currents are used; but this, of course, entails an increased initial outlay and about 12 to 18 per cent. for depreciation. It appears, so far, that electricity can be applied, and made to work all the known kinds of hoisting machinery; but whether it can ever compete successfully with hydraulic power for general use still remains to be proved. In case of hoisting machinery, such as lifts, there is no doubt that the direct-acting ones are far preferable to those that are electrically worked. In Victoria Mansions, Westminster, London, where the author's offices are situated, there are several hydraulic lifts, and two of them have lately been fitted with an independent accumulator and a set of three-throw pumps, the latter worked by an electric motor. By this means the power-water is, after passing through the cylinders, returned to a tank and used over and over again. The motor is compound wound and drives on to a worm wheel, the end thrust of the worm shaft being taken by a series of small hard-steel balls working between two hard-steel grooved rings, which system the author first suggested in 1889. The total efficiency of the combined machines, that is to say, the proportion between the horse-power in the water pumped and the horse-power absorbed by the motors is over 50 per cent., and, as far as time has permitted a judgment to be made, the arrangement is giving satisfactory results. The switching on and off of the currents are controlled by the rise and fall of the accumulator weights. This system might find suitable applications in other cases, but would have to be governed by the price of water.

With regard to working cranes or travellers by electricity, both shunt and compound wound motors are used; but the advantages lie chiefly with the latter, as, by using that system of winding, a uniform speed of motor is obtained irrespective of the weight lifted, and again it enables the machine to be stopped and started with the load on. For engineering shops, foundries, setting of concrete blocks, &c., this, of course, is of primary importance, and it will be found best to have separate motors for each movement, such as lifting, travelling, and racking, as not only is mechanical gear saved, but it gives the driver easy and undivided control of each movement, leaving his whole attention to be devoted to the object lifted. The mechanical construction of the cranes or travellers can, of course, be made of any type, for instance:—

(*a*) When one motor only is used on a traveller it can be made to drive a transverse endless rope passing over and under a series of pulleys and jockey pulleys attached to the crab frame, the said pulleys actuating the various movements either by clutches or open and crossed bands.

(*b*) Or where a separate motor is used to work each movement, if compound wound, would be rigidly attached to one of the spur pinions in connection with the respective gears.

(*c*) Another system would be to attach the motor to the travelling crab, which would save some friction in the way of driving it from one end.

In the case of cranes the motors are generally made to work direct on to a worm, the wheel being on the drum shaft or directly geared to it, or the shaft of the armature may be fitted with a pulley with a slightly hard but compressible face and pressed against the face of another driving pulley geared to the barrel, and so driving by friction.

The most recent electric cranes that have been put up in England are those at Southampton, the framework being made by Messrs. Stothert & Pitt, and the electrical portions by Messrs. J. G. Statter and Co. These cranes are very much on the lines of those supplied to the Hamburg docks, and manufactured by Messrs. Siemens and Halske, of Berlin.

The author points out that these cranes weigh 35 tons, and the price is £1,450, while for hydraulic ones of the same capacity arranged in a similar manner, the weight would be 28 tons, and the price £750.

The tests alluded to by the author were carried out with the view of determining the following:—

1. E.H.P. absorbed by the motor when lifting the chain and hook with no load, so as to determine the friction of the machine.
2. E.H.P. absorbed when lifting known weights at known speeds.
3. Energy in horse-power put into the weight lifted.
4. The efficiency of the machine.
5. E.H.P. absorbed by motor when lowering the load.
6. E.H.P. absorbed when travelling and lifting.
7. E.H.P. absorbed when travelling and lowering.

First Test.—Single 8-H.P. motor, shunt-wound, driving a traveller by means of endless gut rope and crossed and open bands, as previously described, 80-volt circuit.

When lifting chain, block, and hook, 6 E.H.P.; when lifting six tons at 2 feet a minute, the E.H.P. was 7·6, and the actual horse-power in weight, 1·04; when lifting 1·7 tons at 18¾ feet a minute, the E.H.P. was 10·5 and the actual horse-power in weight, 2·2; efficiency of machine at 6 tons, 13·5 per cent.; efficiency of machine at 1·7 tons, 21 per cent.

Second Test.—Single 8-H.P. motor, shunt-wound, working a traveller, driving and travelling by a transverse shaft with compressed paper friction cones at each end, driving two cross shafts by means of being pressed against chilled iron coned discs, 100—105-volt circuit.

When lifting light, 1·77 E.H.P.; when lifting 7 tons at 7 feet a minute, 5·75 E.H.P.; energy in horse-power put into weight, 3·32; efficiency of machine, 57·7 per cent.

Third Test.—This was an ordinary hand-power foundry traveller, converted for working electrically, and was driven by one single motor at one end, all the other motions being taken off one transverse shaft.

When lifting light (quick speed), 2·83 E.H.P.; when lifting light (slow speed), 2·4 E.H.P.; when lifting 4 tons at 8·9 feet a minute, the E.H.P. was 7·73; and actual horse-power in weight, 2·42; when lifting 4 tons at 3·4 feet a minute the E.H.P. was 5·0 and the actual horse-power in weight, ·9; when lifting 9, 13·5 and 18·5 tons at 3 feet a minute, the E.H.P. were 6·8, 9·6, 9·9, while the actual horse-powers in weight were 2, 3, and 3·7; the efficiency of the machines in the above cases varied from 29·05 to 37·5 per cent.

Fourth Test.—When lifting light, 4·01 E.H.P.; when lifting ·75 ton at 200 feet a minute, the E.H.P. was 25·16, while the actual horse-power in weight was 10·17; when lifting 1 ton at 200 feet a minute, the E.H.P. was 31·68, while the actual horse-power in weight was 13·57; when lifting 1·2 tons at 200 feet a minute, the E.H.P. was 36·86, while the actual horse-power in weight was 16·29; when lifting 1·5 tons at 200 feet a minute, the E.H.P. was 42·02, while the actual horse-power in weight was 20·35; efficiency of machine when lifting the different weights was 40·4, 42·8, 44·1, 48·4 per cent.; when slewing at full speed 1·86 E.H.P. was consumed.

In all the above cases, if the E.H.P. used when lifting light be deducted from the E.H.P. when lifting loads, the net efficiency attributable to doing work is good, viz., 65 and 49 per cent. in the first case, 71·7 per cent. in the second case, 50 per cent. in the third case, and 53 per cent. in the last one, thus pointing to the direction in which further efficiencies could be obtained.

From this it will be seen the total efficiency of the machines in tests Nos. 1 and 3 is not high, the worst result being No. 1, the loss of power in this case being evidently due to the necessity for a large amount of gearing when working such a machine from one high speed motor.

Some short time ago the author was called in by the Southampton Harbour Board to make a report on the question of supplying power cranes to their jetties and wharves, either on the steam or hydraulic system, and for the purpose of general comparison in the case of such an installation, he will now give the conclusions arrived at, and supplement them by figures relating to an electric plant for doing the same work.

The installation at the outset was to have been only a small one, and comprised the following:—

Hydraulic.—One pair of compound condensing engines and pressure pumps; accumulator; two boilers; six 30-cwt. cranes, with 30-feet jib radius; two 20-cwt. luggage cranes, with 30-feet jib radius; six large and 10 small capstans; pipes and connections, engine house and shaft.

Steam.—Cranes, self-contained, same as above; capstans, same as above; steam pipes, two capstan boiler houses.

Electric.—Two pair of compound condensing engines and dynamos; two Lancashire boilers; cranes and capstans, same as above, but fitted with motors; mains.

The total cost of the various systems, including the engine house and shaft, in the case of hydraulic and electric works, came out as given below; but it does not include the laying of hydraulic mains or the electric conductors, and it must be noted that the steam cranes are assumed to be self-contained and not supplied from a battery of boilers:—

Hydraulic, with engine house	£13,561
Steam	11,120
Electric, with engine house	11,736

The advantages and disadvantages of the several systems are summed up as follows:

Steam Advantages.—(*a*) The first cost of installation is less than for hydraulic or electric plants.

(*b*) In the case of the cranes only, as they supply their own motive power, they cannot be affected by the failure of a main or the machinery at the power station, as in hydraulic or electric.

(*c*) The installation can be added to gradually at a less initial cost than with hydraulic or electric plants, where the power station should be sufficiently large for the maximum duty likely to be required from it.

Disadvantages.—1. It is slow in action compared to hydraulic or electric power, working only at about half the speed.

2. Each crane generating its own power; they are more costly to work than hydraulic or electric cranes, where one generating station supplies power for the whole plant.

3. The drivers of the cranes have to be men of above the average intelligence, and fairly good mechanics.

4. The consumption of coal and fresh water is considerable, and if the cranes and capstans were not required to work, but kept in a state of readiness, more coal and water would be consumed than for the hydraulic or electric plant, if they were kept idle in a similar manner, there being so many more boilers to keep under fire, viz., one to each crane and one stationary, one to each group of capstans.

5. The cranes are noisy, and owing to great speed, have much vibration, with consequent wear and tear entailing a high cost for repairs, and danger of fire, as the boilers are liable to emit sparks with the smoke.

6. Generally they require to be supplied with coal from a store, entailing labour and creating dirt on the quay. The machinery is more complicated than hydraulic, and partly exposed to the weather, in addition to which its wear and tear is considerable, and there are possible risks of explosion.

7. The cost of working is higher than hydraulic or electric.

Hydraulic—Advantages.—(*a*) The power for working the plant being generated at a central station, the cost of working is reduced to a minimum, there being only one set of boilers to fire, and practically no fresh water is required beyond a few gallons daily.

(*b*) The machinery is quick in action, at least twice the speed of steam, and speed for speed for lifting, compared with electric, has a much less wear and tear, the cranes being capable of working 60 lifts per hour, or more if desired. At the trial of the large hydraulic 35-cwt. cranes made for the Tilbury Docks, 81 working lifts were made in 47 minutes, in which the goods were lifted out of a boat, slewed round, and landed on the quay.

(*c*) Only one driver and stoker is necessary; a lower and cheaper class of men can work the cranes and capstan than is the case in steam-driven ones. It is, however, necessary to have one skilled mechanic to generally look after the work.

(*d*) If the plant should be required to stand idle for any length of time, only a very small amount of fuel would be consumed.

(*e*) Generally the machinery is noiseless, simple, clean, all protected from the weather, and has not much wear and tear; the cranes can be easily moved along the quay.

(*f*) Besides the hydraulic power being used to work the machinery already referred to, it would be available for elevating purposes in neighbouring warehouses and for the extinction of fires by means of injector hydrants.

(*g*) The cost of working is less than by steam, but about the same as by electricity, but the upkeep is less than either.

Disadvantages.—1. The initial cost is greater than for steam and slightly more than for electric cranes.

2. In the case of a breakdown at the power-generating station, or failure of the mains, all the plant would be temporarily stopped. Although the author mentions this, he does not consider it at all likely to occur, nor does he know of any case where this has taken place; it is only necessary to have all details made amply strong.

Electric—Advantages.—(*a*) The power for working the plant being generated at a central station, the cost of generating is reduced to a minimum, &c., the same as in hydraulic.

(*b*) Machinery is quick in action, though not quite so quick as hydraulic.

(*c*) Only one driver and stoker is necessary, &c., the same as in a hydraulic plant.

(*d*) If the plant should be required to stand idle, &c., the cost is the same as for a hydraulic plant.

(*e*) Generally the machinery is fairly noiseless; it is cleaner than either steam and hydraulic, and can easily be arranged to be self-propelling along the quays.

(*f*) The power can also be used for lifting purposes in neighbouring warehouses.

Electric—Disadvantages.—1. Speed for speed of lifting, there would be more wear and tear than in the hydraulic system.

2. In case of breakdown at the power generating station or the failure of a main, all the plant would be temporarily stopped.

3. The drivers of the cranes would have to be men of above the average intelligence.

4. The upkeep would be slightly more than in the case of a hydraulic plant.

With regard to the cost of working the above systems, the author estimates them as follows:—

APPROXIMATE ESTIMATE AFFECTING THE COST OF WORKING.

	Hydraulic and Electric.	Steam.
Coal for capstans, presuming steam in boilers is kept up all day and capstans ordinarily at work.	.....	20 to 25 cwt.
Coal consumed per day of 10 hours when working 8 cranes continuously.	35 to 40 cwt. The greater would probably include the use of capstans	70 to 80 cwt.
Water (fresh) consumed per day of 10 hours when working 8 cranes continuously.	Practically *nil*.	4,600 gallons.
Coal consumed when machinery standing idle and steam in boilers kept up.	1 cwt. per hour ...	½ cwt. per hour each crane, and ½ cwt. per hour each capstan boiler.

The author concludes that, all things considered, the hydraulic system is the most satisfactory one, and considers that more improvements will be effected in this system than in steam or electricity.

LEGAL.

MANVILLE *v.* GRAMSHAW.

THE case of Manville *v.* Gramshaw, an action to recover damages for breach of contract, was heard yesterday week in the Queen's Bench Division of the High Court before Mr. Justice Lawrance and a common jury. Mr. A. J. Walter appeared for the plaintiff, and Mr. Winch, Q.C., and Mr. Arnold Statham for the defendant. This was an action to recover the balance of a premium of 200 guineas, which was arranged to be paid to Mr. Manville (the electrical engineer to the Dublin Corporation and many other important bodies) by Dr. Gramshaw, of Stillington, near Easingwold, for the education of his son as an electrical engineer.

Mr. WALTER, in opening the case, explained that in 1890 the plaintiff, Mr. Manville, the well-known electrical engineer, was managing director of the Electrical Engineering Corporation (late the Jablochkoff Electrical Company), and having made the acquaintance of the defendant at his place in Yorkshire, entered into negotiations by which the son of the defendant, Mr. Sydney Gramshaw, was to be taken by him at the works of the Electrical Engineering Corporation, in order that he might be taught the business of an electrical engineer. It was arranged that the amount of premium should be 200 guineas, to be paid in instalments of 50 guineas each. The arrangement having been made, the son of the defendant went to the works, and the first instalment was paid. In the following January the works were burned down, damage was caused to the extent of £14,000 or £16,000, and the company subsequently went into liquidation. It was then arranged that Mr. Manville should take Mr. Gramshaw, junior, and continue his education at the works of the Dublin Corporation. It might be stated that the arrangement was one personal to Mr. Manville, and that he got the fees to be paid as premium. Mr. Gramshaw, junior, went to the Dublin works, where he was able to obtain the most satisfactory and valuable experience. No further payment having been made by Dr. Gramshaw, the plaintiff wrote several letters, asking for further payments of the premium arranged, but no notice was taken of these letters, and eventually the present action was instituted.

The evidence of Mr. MANVILLE was, that in 1889 he was director of the Electrical Engineering Corporation, and superintending an installation at a Yorkshire mansion. Defendant wanted his son to be a pupil of the Corporation, and it was arranged that the premium should be £200. Owing to a fire which occurred at the company's works at West Drayton, the company were obliged to go into liquidation. Young Gramshaw was transferred to the plaintiff as pupil, and plaintiff, who was erecting a central installation station for the City of Dublin, sent him over there. After a few months Gramshaw left, and took a situation as wireman at £1 a week.

The agreement as to the tuition having been produced, it was found to be unstamped, but Mr. Walter said he was willing to pay the penalties if it was found necessary to use the document.

Other evidence having been adduced,

Mr. WINCH, for the defence, submitted that there was no case for the jury, but the judge held that it was a case for the decision of the jury. Mr. Winch then addressed the jury for the defence, contending that it was absurd for a man to be called upon to pay 200 guineas to have his son sent away to take positions at electrical works at various parts of the country. He contended that the fire which extinguished the Electrical Engineering Corporation had put an end to the agreement, and that Mr. Manville could not fairly claim the balance of the premium (£150) simply because he sent the young man to Dublin. Mr. Manville only went to Dublin once a month, so that he could not possibly argue that he had taught the young man his business as originally agreed.

The defendant and his son gave evidence. The former denied that his son was transferred to the plaintiff from the Corporation, and the latter said at Dublin nothing was explained to him, and he was gaining no knowledge.

The jury found a verdict for the plaintiff for the full amount claimed.

CORRESPONDENCE.

The Starting of Railway Motors.

In your note on my article in *Industries and Iron* on the Worby-Beaumont variable power, you state that Mr. Kapp's suggestion of fly-wheel dynamos is not correctly referred to by me in my article, and that Mr. Kapp intends the fly-wheels to be fixed to the generators.

My interpretation of Mr. Kapp's suggestion is prompted by Mr. Kapp's contribution to the discussion on Hopkinson's paper on "Electrical Railways" (*Min. Proc.*, Inst. C.E., Vol. cxii.), in the course of which he says, after describing an application of his principle to a case of transmission of power in Switzerland :—"It would show what might be done on electric railways if they were to put on, in one or two parts of the line, a shunt wound dynamo with a magnet excited in a particular way, and driving a fly-wheel, but doing no other work."

It is quite clear from this and from other remarks which I need not quote, that these dynamos were intended to work part of the time as motors and part of the time as generators.

Your concluding paragraph suggests that you have missed some of the points of my argument. You say, "The loss is not so much in the large current at the start as in the resistances introduced to keep the current down to a safe value."

Now the great source of loss is in the extra boiler, engine, and dynamo power, the extra copper in the mains and other extras, necessary to deal with this large current at starting, and, obviously, any device tending to ameliorate "the worst possible case" which is a large factor governing the design of electric railways, would of necessity react favourably upon the capital expenditure in the first instance.

If Mr. Worby-Beaumont's gear will reduce the current required to start a train, other conditions being the same, not only will the car losses be affected, but, the "worst possible case" would approach that of all cars travelling at once, which would have a different significance to the present "worst possible case," namely, that of all cars starting at once.

Ed. C. de Segundo.

[The Worby-Beaumont gear is to be inserted between the motor and car axle for the sole purpose of saving the motor from the large inrush of current at the start, as it allows the motor to start off with a light load. The fly-wheels were suggested as reservoirs, to be drawn upon for the large currents required where no variable gear is inserted, and we pointed out this difference between the two appliances—Mr. Segundo not having done so in his article. Storage batteries would effect the purpose of the fly-wheels quite as well, if not better, but storage batteries could not effect the purpose of a variable gear. We quite admit the loss is in the great extra plant required to meet the "worst possible" cases arising from the large starting current, but we do not agree with the fly-wheel proposal as being capable of ameliorating the worst possible case, and we must point out that the root of the whole question is the starting of the motors. In the case given by Mr. Segundo, of Hopkinson locomotives, with two in series, the starting current is, without resistances, about 320 ampères, equal to over 100 H.P.; this is not required, so resistance is inserted not to save some of this power, but to waste it. Storage on the mains, whether by fly-wheels or batteries is useless to effect any improvement in this difficulty. The only direction for improvements are to be looked for in a rational use of storage on the cars or by transformers. —EDS. ELEC. REV.]

Fuel Economy.

Referring to the article published in your last issue under the above heading, there can be no doubt that the utilisation of slack, dust coal, and refuse fuel, is a matter of greater commercial importance than is generally realised, definite knowledge of the subject being at present confined to a comparatively few engineers and others who have given it special attention. There appears, however, to be ample evidence to prove: (1) That the slack or "peas" of good steam coal will evaporate—weight for weight—at least as much water, and often more, than large coal of the same quality, provided it be burnt in a suitable furnace and *under a strong draught*.

(2) That inferior slack or dust coal, coke dust, &c., when burnt under proper conditions and a strong draught have an evaporative efficiency of from about 60 to 70 per cent. as compared with that of steam coal; and therefore a proportionately greater weight of these inferior fuels must be used to obtain the same duty.

The foregoing results are primarily due to the strength of the draught or blast, to its fine distribution, and to the smallness of the fuel, which enable each particle of fuel to obtain its full amount of air, thus ensuring complete and vigorous combustion. This view is confirmed by the fact that with large coal there is often no material gain with forced draught.

The above calorific results, though important in themselves, are much more so when taken in conjunction with the relative prices of these fuels which must be considered in order to obtain the cost, that is to say the actual *money* expended in evaporating a unit of water, this unit being generally taken at 1,000 gallons.

Well, prices vary in different districts, but good slack probably costs, on the average, 30 per cent. less than large

coal, and therefore in the first case mentioned the economy effected—expressed in money—would be fully 30 per cent., minus the cost of producing the blast.

With regard to the inferior and dust fuels it is difficult to state general prices, but as a rough average they probably cost 50 to 70 per cent. less than steam coal, and on this basis, and after making due allowance for the extra weight required, we have a saving of from about 30 to 50 per cent. in the cost of evaporating a unit of water.

The only means of burning these small fuels (other than the method described in your article), is by a very strong or "forced" draught, such as that given by my apparatus described in your journal for July 14th last, and also by similar systems of forced draught.

W. A. Granger.

Mattei's Liquid Electricities.

It may interest your correspondent referred to in last week's issue to know that in the summer of 1890, if my memory serves me correctly, there appeared in the *National Review* some articles on these curious potions, in consequence of which a controversy arose between a surgeon of the Cancer Hospital, and a gentleman who championed the count's remedies. In the course of this controversy, the latter articles were subjected to analysis by a well-known scientist, with the result that he was unable to find any other ingredient in their composition than that very useful and well-known one understood by the symbols H_2O! *Verb. sap.*

H. G. Tozer.

The Late Mr. Reckenzaun.

Will you allow me a space in the columns of your journal, which has amongst its readers so many of my late husband's friends, to thank them for sending me, in such numbers, letters of sympathy and condolence.

Their number is far too great for me to reply to them individually, and I hope you will give me this opportunity of expressing to them my warmest thanks, and the gratification it is to me to know how universally my husband was beloved and respected.

E. Reckenzaun.

NOTES.

The O.S.A.—The history of the Old Students' Association of the City and Guilds of London Institute is a sequence of partial failures and decided successes. We are glad to hear that there is a vigorous attempt being made to remove altogether the sources of failure, and to add to it everything which should make it prosperous. In other words, it is now decided to hold meetings for the reading of scientific papers only under special and rare circumstances; leaving the Association free to be worked upon more distinctly social lines. At first sight it appears retrograde to eliminate the scientific element from these meetings, for it gave tyros a chance to read their papers before an audience less harshly critical than the average technico-scientific body. Except upon a few occasions, however, such meetings were very poorly attended, the discussions were very feeble, and the general impression unsatisfactory. At the same time it is felt that there are many channels open for scientific matter, where greater justice could be done both to the readers and their papers. This is undoubtedly true, but it is to be hoped that the "O.S.A." will not degenerate altogether into a social club, and nothing else; it would be a great waste of good material; and, if support is to be expected from the outside, it would be much more freely given, we venture to think, to an association tinctured with science, than to a mere gathering of past students for social intercourse. There is a *status* and a plausibility about a scientific society, which does not belong to a social club; the "O.S.A." has to decide between them, with a view to present needs and future possibilities.

Bristol Electric Lighting.—The electric light was last Friday turned on in Corn Street and Baldwin Street. The experiment was a great success.

Electrical Engineer Charged with Fraud.—Henry Everard Hunt, electrical engineer, manager of the Taunton Electric Light Works, was remanded at Taunton Police Court on Saturday, charged with forging a promissory note for £233, with intent to defraud.

Shanklin and Electric Lighting.—A member of the Local Board suggests the public lighting of the town by electricity. It is to be hoped his suggestion will be followed up by practical work, as this exquisite pleasure resort would be greatly improved by electric lighting. The celebrated Shanklin Chine would be an exceedingly pretty sight illuminated by electricity.

German Electric Tramways.—Messrs. Siemens and Halske, of Berlin, have concluded a contract with the local authorities of Gelsenkirchen for the establishment of electric tramways in that neighbourhood. The communes interested are to establish the roads for laying the lines; and in consideration of their doing this, they are to receive 25 per cent. of the net profits and charge interest at the rate of 5 per cent. per annum upon the capital expended. *Engineering* states that the concession of the lines is only granted for a term of 30 years, and at the expiration of that period the lines will become the property of the communes. The concession will probably be vested in the first instance in Messrs. Siemens & Halske.

Coast Communication.—In the House of Commons on Thursday last week, Mr. Arnold Morley, questioned by Sir J. Leng, said the number of lighthouses on the coasts of the United Kingdom which have been provided with electrical communication is 22. This number includes Lundy Island, Fair Isle, and the Gunfleet Pile Lighthouse. The Royal Commission on Electrical Communication with Lighthouses, &c., have recommended that communication be also extended to Caldy Island, the Taskar, and the Fastnet. As to any further extension, they have not yet reported. Mr. Mundella, replying to Sir J. Leng, said: The work of connecting the North Goodwins and the Kentish Knock light vessels with the shore by electric cables will, I hope, be completed before the end of the present financial year. This will exhaust the money voted for such communications.

French Enterprise.—It was announced recently that the three most important cable manufacturing companies in France had entered into a combination. These companies were the Société Générale des Téléphones (which owns a submarine cable manufactory at Calais), and the two companies of Messrs. Rattier and Menier. The joint companies now bear the name of the Société Industrielle des Téléphones, having a capital of £624,000. It is evident from the following telegram from Paris, which we reprint from the *Standard*, that the French Government intend, as far as they can, to foster the cable industry in France, and that they wish to be no longer dependent on English labour and English capital for means of communication with their colonies, scattered and few as they are:—"A Commission has been instituted by the Posts and Telegraphs Department to study the question of the International telegraphic communications of France. This Commission, which comprises several Senators and Deputies, delegates from the Ministers of Foreign Affairs, War, the Marine, and Commerce and Industry, as well as superior functionaries of the Colonial Department and of the Posts and Telegraphs Administration, met the other day for the first time. The work of the Commission consists in drawing up the programme of all the telegraphic communications, the establishment of which is deemed necessary in the interest of France, the estimation of the cost of the various lines, and the order in which the works should be carried out. After an exchange of views, in the course of which it was declared that it is now more imperiously necessary than ever to organise a system of French submarine telegraphic cables, the Commission charged a Sub-Commission to elaborate a comprehensive plan, and to prepare certain projects, the carrying out of which was regarded as particularly urgent."

The Late Mr. Weaver's Will.—The value has been sworn at £83,695 of the personal estate of the late Mr. Henry Edward Weaver.

Lighthouse Lights.—Some very useful articles upon "Lighthouse Illumination" have recently been concluded by M. Bochet in *L'Electrique*.

Leeds Association of Engineers.—The 28th annual dinner of the above Association was served on Saturday last, at Queen's Hotel, Leeds.

Hampstead Electric Lighting.—The London County Council, on Tuesday last, agreed, on the recommendation of the Finance Committee, to lend the Hampstead Vestry £25,000 for electric lighting purposes.

Colour Contrasts.—The *Electrical Engineer* of New York contains an account of some very interesting experiments made by Prof. Alfred M. Mayer, upon the phenomena of simultaneous colour contrasts. The third article upon this subject is given in the issue for November 22nd.

Institution of Electrical Engineers.—The balloting list for council and officers for the year 1894, to be brought forward at next Thursday's meeting (December 14th), recommends the appointment of Mr. Alex. Siemens as president, and Prof. Geo. Forbes as additional vice-president, also the following additional members of council. Ordinary members of council:—Major A. J. Bagnold, R.E.; W. B. Esson; Robert Kaye Gray; Augustus Stroh. Associate members of council:—G. K. B. Elphinstone; Dr. W. E. Sumpner; and Earl Russell.

Electric Traction.—A correspondent writes to us as follows in regard to our leader of last week on this subject:—"Should we not, while considering the losses in starting, give attention also to those in stopping? The possibility of storing the energy of the moving vehicle by means of a powerful spring has, I believe, been demonstrated in connection with horse cars. The particulars of this I have not at hand, but the experiments were noticed in some of the papers about a year ago." Our correspondent is perfectly correct. There have been no end of experiments carried out for storing the energy of the moving vehicle by means of a powerful spring, but so far none of them have been successful.

Leeds Tramways.—The Highways Committee of the Leeds City Council, last week, considered the subject of applying electricity as a motive power on the Leeds tramways. The undertaking is to shortly come into the possession, by purchase, of the corporation, and it is thought that opportunity might be taken of the change to introduce electricity instead of horse and steam power. Mr. Robert Hammond attended the committee meeting and conferred with the members as to the different systems in operation throughout England and other countries. He described the conduit system in use in Buda-Pesth, and replied to numerous questions put to him by members regarding the working of the overhead wire system.

Reduction in the Charge per Unit at Scarborough.—The Scarborough Electric Supply Company, Limited, has issued a reduced scale of charges which will take effect as from October 1st last until further notice. The company's charge per Board of Trade unit for electric energy will vary with the number of units consumed in each quarter, in accordance with the following scale:—

Number of units consumed per quarter.	Price per unit.
Not exceeding 200 units	6½ pence.
Exceeding 200, and not exceeding 400 units ...	6¼ „
„ 400, „ „ 800 „ ...	6 „
„ 800 units	5¾ „

(One unit will maintain an 8-C.P. lamp for 32 hours.)

A cash discount of 5 per cent. will be allowed on all quarterly accounts if paid within 14 days. In addition, the charge for meter rent will be 2s. per quarter for any number of lights not exceeding the equivalent of 50 8-C.P. 35-watt lamps, with 6d. extra per quarter for every additional 25 such lamps or their equivalent connected. The directors trust that a largely increased use of electricity will justify the considerable reduction in price they have made.

Kingston Electric Lighting.—According to the local newspapers the arc lamps in several streets have been by no means satisfactory during the past week or ten days.

Lectures on Electric Lighting.—Mr. H. Scholey is trying to organise a body of lecturers for the purpose of delivering addresses on the lighting of towns by electricity.

Count Mattei's Remedies.—On the subject of our last week's note we have received, too late for publication in the present issue, a letter from Mr. A. J. L. Gliddon, which we are compelled to hold over until next week.

The City Lighting.—The Commissioners of Sewers, considering that electric light is now the light of the City, have resolved to abolish the gas standards. A number of members offered opposition, but this had little effect.

Denmark-Sweden Telephones.—The telephonic service between Denmark and Sweden was formally opened at 2 o'clock on Tuesday by King Christian and King Oscar, who exchanged congratulatory messages upon the new means of intercourse established between the two countries.

The Scotch Coal Strike.—The coal strike in Scotland is responsible for the stoppage of the electric lighting plant at the Glasgow Queen Street Central Station last week through want of steam power to work the dynamos. The gas had to be lighted until a waggon of coals could be secured.

Appointment.—Mr. G. Church has been selected by the Indian Government for appointment as mechanical engineer to the Indian Telegraph Department. The intention to appoint an electrician to the same department has been abandoned.

Glasgow Electric Tramways.—A Chicago contemporary states that one of the largest European orders for street cars in several years, has been let by the city of Glasgow. It is for 200 cars, to cost $150,000, and has been divided among English builders.

O.S.A.—There will be a meeting of the students of the Institution of Electrical Engineers at 8 o'clock on Friday, the 15th inst. A paper on "The Brightness of Light: Its Nature and Measurement," by Messrs. T. M. Barr and C. E. S. Phillips, and a letter concerning the premium offered to students by the Institution will be read.

St. Paul's Cathedral and the Electric Light.—The Restoration Committee of St. Paul's, at their meeting on Tuesday appointed a sub-committee to enquire as to how and at what expense the electric light can be introduced into the Cathedral. If the Restoration Committee decide to have the light, an appeal will have to be made for special funds.

Vibration.—Mr. H. T. Steward has made his award in the arbitration arising out of alleged injuries to the Monte Carlo Hotel, Leicester Street, by the electric lighting engines of the Empire Theatre, for which £2,000 damages were claimed. The *Daily News* states that the award is in favour of the Palace Company on every point, M. Guffanti, the claimant, having to pay all costs.

Blackburn Electric Lighting.—Last Friday a Local Government inquiry was held at Blackburn into an application by the Corporation for sanction to a loan of nearly £200,000 for the erection of new gasworks. "The old plant has for some time been worked at high pressure, and consequent enhanced expense, and the provision of the new works will allow the old gasworks to be devoted to electric lighting purposes."

City and Guilds of London Institute.—The annual presentation of prizes and certificates to the students of the various colleges connected with the Institute took place on Wednesday evening (December 6th) at Goldsmiths' Hall. The Lord Mayor presided, and the prizes and diplomas were distributed by Sir Richard Webster. According to the report, out of a total of 9,149 candidates at the recent technological examinations, 4,847 obtained passes, being an increase of 420 on the previous year.

Portsmouth Electric Lighting.—The works are now approaching completion, and it is expected that the inaugural ceremony will be performed in January. The task of switching on the light will be entrusted to the mayoress (Mrs. A. L. Emanuel). A large number of applications for the new illuminant have been received from shopkeepers.

Lectures.—At the London Institution, Finsbury Circus, last Monday, Prof. C. V. Boys, F.R.S., lectured on "When and why an Electric Spark Oscillates."

Professor A. B. W. Kennedy delivered the first of two lectures on "Engine and Boiler Testing" at the City and Guilds Technical College yesterday evening. The second lecture will be given on the 21st inst.

Prof. John Perry has been delivering a special course of lectures on "Steam in the Cylinder" before the same College during October and November.

At a recent meeting of the Free Lances at "The Cambray," Cheltenham, a lecture on "Electricity" was given by Mr. J. E. Killick, who illustrated his remarks with experiments.

Before the Northern Architectural Association last week, Mr. E. Brown, M.I.E.E., read a paper on "Electric lighting," illustrated by diagrams.

Inquest on Prof. Tyndall.—It was found at the inquest held yesterday that Prof. Tyndall died through the mistaken administration of chloral for magnesia.

CONTRACTS OPEN.

Derby.—December 16th. The Corporation are prepared to receive tenders for the wiring, fittings, &c., to the various public buildings situated on the electric lighting area, viz.: Market Hall, Town Hall, Babington Lane offices, Full Street Baths, Weights and Measures Inspector's House, Police Stations, and Fire Brigade Station, Derby. Particulars from the Borough Engineer, Babington Lane.

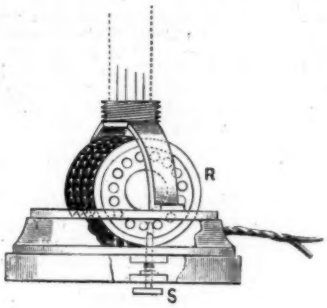
Swindon.—December 11th. For the following, for the Swindon New Town Local Board, viz.: (1) For the supply of gas, oil, or electric light to, and lighting and cleaning of all lamps within the district of Swindon New Town for one year, commencing January 1st; (2) for the supply of gas, oil, or electric light only for all lamps within the district for one year, commencing January 1st; (3) for the lighting and cleaning of all lamps within the district for one year, commencing January 1st. Further particulars from the Town Clerk.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (12th year). This is a directory of the electrical trades embracing the whole Universe, and having no superfluous matter irrelevant to a directory it can be sent everywhere, carriage paid, for 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

Electric Light in Coventry.—At the meeting of the Coventry Council last Tuesday, the Electric Lighting Committee presented the following report:—"In accordance with the instructions of the council your committee called in Mr. A. H. Preece, of Westminster, to advise them, and submitted to him the tenders of the Brush Electrical Engineering Company, Limited, and Messrs. Hammond & Co., with John Fowler & Co. (Leeds), Limited. On a careful analysis and comparison of the tenders, Mr. Preece reported that, after making certain additions to and deductions from each in order to reduce them to a common basis, that of Messrs. Hammond and Fowler was the lower by £278, and he recommended the acceptance, subject to certain small modifications to which Messrs. Hammond and Fowler have agreed. Mr. Preece also recommended that for the purpose of supplying current at times of light load a small plant of 15 kilowatt capacity should be added to the equipment of the station. Your committee have received an offer from Mr. Robert Hammond, who is associated with Messrs. John Fowler & Co., Limited, in this matter, to retire from the contract in order to act as consulting engineer to the corporation for the execution of these works at a commission of 5 per cent., the contract being placed with Messrs. John Fowler & Co. (Leeds), Limited, at 5 per cent. less than the figure named in the tender. To this Messrs. John Fowler & Co. are ready to agree. Your committee recommend that this arrangement be carried out, as it will give the council the advantage of the assistance of Mr. Hammond's great experience and energy in carrying out the works without adding to the cost. Your committee accordingly recommend that the tender of Messrs. J. Fowler & Co. (Leeds), Limited, be accepted, subject to their entering into a proper contract, and guaranteeing the efficiency of the generating plant to be not less than 75 per cent. at full load. The acceptance will also be subject to the sanction of the Local Government Board being given to the necessary loan. The amount of the tender as it stands is £8,843 6s. 6d. To this must be added the cost of trenching the streets, and of the small plant above mentioned, about £1,000 in all. There are also the the purchase money of the site, the cost of buildings, and the wages of the clerk of the works to be provided for. While not anticipating that the estimate of £15,000 formerly mentioned, will be exceeded, your committee recommend that application be made to the Local Government Board for their sanction to a loan of £20,000."

New Portable Lamp Standard.—A new patent automatic self-winding portable electric lamp standard has been invented by Mr. Killingworth Hedges. The following advantages are claimed for it: The flexible wire is automatically wound up on a reel, R, contained in the base by means of a spring, thus preventing the flexible becoming damaged when the lamp is not in use. When the lamp is in use the slack is taken up by the reel, and obviates the risk of it becoming entangled, which frequently happens when a long length



of loose flexible wire is used, as in the ordinary standard. It is also fitted with a patent stopping gear, which comes into action when the lamp is placed on the table and relieves the wire from the strain of the spring, thus preventing the lamp being turned over, or wall-plug pulled out. The stopping gear consists of a small stud, s, fitted in base, which engages in pins on the side of the reel when the standard is placed on the table, and releases it when the standard is raised from the table. The above automatic self-winding arrangement is also applicable to floor standards. The Carboid Oilless Bearing Company, Limited, who are also makers of Hedges's mica-foil fuses are introducing this standard to the market, and samples can be inspected at 7, Carteret Street, Westminster, S.W.

Lancaster Electric Lighting.—The Town Council have resolved that the sum of £1,400 be voted to the Brush Electrical Engineering Company, Limited, on account of works completed under the electric lighting contract, and have authorised the Electric Lighting Committee to pay the contractors such sums as may be certified by the surveyor as due to them, being not more than 80 per cent. upon the value of the work completed by them during the month of December. The license agreement between the Westinghouse Electric Company and the Corporation, with reference to the three-wire system patent, was submitted, and it was resolved that the agreement be approved. It was resolved that private telephonic communication be established between the surveyor's office and the electricity works at a cost of £12. It was also resolved that the surveyor be authorised to purchase the following articles: 50 Ferranti meters; 2 three-wire system meters for the Town Hall and the Storey Institute; service fuse boxes (as required); 50 frames and covers for service boxes; lamps (as required). The surveyor reported an application from the proprietor of the Athenæum Hall in St. Leonardgate for electric light. Resolved that the necessary cable be laid as far as the Athenæum Hall, if a sufficient number of the adjoining owners on the route are prepared to take the electric light. Resolved that the price for current for street lighting be fixed at 4½d. per unit. Mr. Alderman Smith, in moving the adoption of the Electricity Supply Committee, said fair progress was being made with the installation, both as to the works themselves and as to laying the mains in the streets, and they trusted to be able to complete the work about the time originally stated—January next. Mr. Alderman Kitchen seconded, and the motion was carried.

Price Lists.—From Mr. W. S. Dougall, of Radcliffe-on-Trent, we have received a list describing his patent papier mâche covering for the perfect driving of machinery. This covering is said to give a perfect steady voltage and stop all snatching of the belt and gives ease to the engine. The covering has been adopted by the Midland Railway Company for St. Pancras Station, Lawley Street and Worcester Wharf, Birmingham and Bradford Station. The above installations have run for 12 months, and given every satisfaction. Mr. Douglas also employs the same covering for driving the Leeds electric tramcars, also at the Raikes Hall, the Aquarium, Prince of Wales's Baths, Blackpool, &c. The Admiralty are also adopting the covering extensively in the dockyards.

Munro's Electrical Manufacturing Company, Limited, have lately brought out a list of prices of switches, switchboards, fuseboards, resistance frames, and similar apparatus.

A catalogue of gas lanterns and lamps, electric lamps, descriptions of all kinds of reflectors, brackets, and similar fittings has been brought out by Messrs. S. Sherman & Son, of New Compton Street, W.C. The book abounds in illustrations, and contains a host of interesting lamp information. The articles described are priced in detail.

Messrs. Selig, Sonnenthal & Co. have sent us a copy of their list of "Sundalo" patent tool holders, and the "British Association" screw plate of the "Lightning" pattern.

The Electric Light at Taunton.—A special meeting of the Taunton Town Council was held on Friday at which the Electric Lighting Committee reported that they had considered Dr. Fleming's recommendations with regard to the extension of the lights. He stated that it would be necessary at once to commence laying some of the underground lines, and he proposed to get rid of the small house transformers and to supply the central portion of the town from one common set of transformers. A high-tension cable would be laid from the works to a cellar under the Municipal Buildings in which will be placed two 30-kilowatt transformers and switches, and from these will be laid an underground three-wire secondary cable, extending in each direction for 220 yards on both sides of the way down four streets. The committee recommend the acceptance of the following tenders:—Messrs. Laing, Wharton & Down, for a small alternator and exciter £280; Laing, Wharton & Down for 30-kilowatt transformers and switches £261 16s.; Messrs. Bumsted & Chandler for a small high-speed 50 horse-power engine £243; Fowler-Waring Co. for a quarter-mile length armoured concentric cable £84 8s.; Fowler-Waring Co. about one mile of triple concentric distribution cable, the exact length to be supplied at 7s. 4½d. per yard. It was complained that the committee had not accepted the lowest tenders. Their first recommendation was adopted, but as to the transformer it was resolved to accept the tender of Mr. F. M. Newton, if his machine met the approval of Dr. Fleming. The other tenders were accepted with the exception of that with reference to the cable, which was offered to the British Insulated Wire Company.

Ship Lighting.—Messrs. J. H. Holmes & Co. have recently completed the lighting throughout by electricity, of Mr. Gordon Bennett's splendid steam yacht, *Namouna*, while she was being fitted with new machinery at Liverpool, the lights being arranged for decorative as well as the most useful purposes. The plant used consisted of a Belliss compound engine, developing upwards of 20 brake H.P. under a strain pressure of 160 lbs. per square inch, coupled direct to a "Castle" dynamo of the Gramme ring armature type. The coupled plant running at the slow speed of 250 revolutions per minute gives a remarkably high efficiency. A battery of accumulators is charged from the dynamo, capable of supplying 27 sixteen C.P. lamps for eight hours. The saloon is brilliantly lighted by a 6-light electrolier of polished brass, arranged in such a way that candles may be used if at any time preferred to the electric light. In addition to this there are ten brackets of similar design to the electrolier, arranged at suitable distances on the bulkheads. The cabins, state rooms, &c., are lighted in a very tasteful manner, the lamps in the state rooms being covered with art silk shades. The lights in the engineers' and officers' quarters, as, indeed, in other parts of the vessel, are also effectively arranged. On the bridge is placed a powerful searchlight.

Smithfield Show.—Messrs. Robey & Co. exhibit at stand No. 1 some specimens of their well-known manufactures among which are the following:—Portable engine fitted with patent automatic governor and link expansion gear running with a practically uniform speed under varying loads; improved compound Robey engine and locomotive boiler combined, fitted with patent automatic governor and link expansion gear; long stroke horizontal fixed engine, class E. type, fitted with patent automatic trip expansion gear; high-speed vertical engine for electric lighting in mills, factories, &c.; improved vertical engine fitted with high-speed equilibrium governor, suitable for driving corn mills and barn machinery; the Robey patent horizontal fixed oil engine; thrashing machine mounted on wrought angle-iron frame.

The Britannia Co., of Colchester, exhibit at No. 6 stand, in the entrance from Upper Street, Islington, a three horse petroleum engine, an engineer's milling machine, and a shaping machine.

Messrs. W. H. Willcox & Co., of Southwark, are making a general exhibit of general engineers' stores. Belting, packing, waste, brass fittings, oils, and similar articles are on exhibition.

Bankruptcy.—At the Nottingham Bankruptcy Court last week, William Andrews came up again for examination. The Official Receiver said the examination had been adjourned from a previous Court in order that the debtor might deliver an account to the trustee of the money expended by him during the twelve months preceding September 29th, the date of the receiving order. The debtor had rendered an account, but it was not regarded by the trustee and himself as being satisfactory. It went very far from accounting for the sum of £900 which he admitted at his examination he had received within a period of two years, he believed, from the time of his bankruptcy. It was to be observed, however, that the debtor had not kept any books, and there seemed no probability of being able to obtain from him any account which would be more definite than the one before them. Therefore, the trustee was disposed, and he (the Official Receiver) was of the same opinion, to offer no objection to the debtor passing his examination. The examination was then closed, debtor being allowed to pass.

"O.E." Electricity Meter.—Mr. Joseph Edmondson, of Bradford, has sent us a wall-sheet description, 25" × 20", of this meter. A good deal of very useful information is plainly set out in table form, which it is clear has taken some time to compile. The illustration of the meter shows up wonderfully well, partly owing to the style of paper and to the high class of printing. It should serve well to keep the "E.O." meter before customers' attention, as one would not object to place this list upon the wall, which cannot be said of some wall-cards.

Zürich Incandescence Lamp Company.—The old factory of the Zürich Incandescence Lamp Company at Birmensdorf, Zürich, was almost entirely destroyed by fire on Saturday, November 25th. The fire was discovered about 3.30 a.m., and the alarm at once given by the watchman on the premises. In response to his call, the fire brigade of the village promptly arrived, followed by those of the surrounding villages, and thanks to their splendid exertions, the new factory, which was nearly completed, was saved with only slight damage, also the books of the company, and a part of the stock. As the Zürich Company have, in addition to the stock saved from the fire, large depôts of lamps in various European centres, it was expected that deliveries of existing orders would be resumed in a few days, and that the interruption to the manufacture would be of very brief duration. The loss is fully covered by insurance.

Omnibus Electric Lighting.—Mr. Kingham, secretary to the London General Omnibus Company, was summoned at Bow Street, last week, for allowing six omnibuses to be in a public thoroughfare after sunset without a light. M. W. Hicks, who appeared for the company, pleaded guilty. He explained that the 'buses complained of were fitted with the electric light, which answered admirably in the summer, but proved a failure in the winter. The difficulty had been caused by an insufficiency of batteries, which took six or seven hours to charge. A new contract had now been entered into; the contractors would supply spare batteries, and would be liable to severe penalties if the light failed. Under these circumstances he ventured to think that a nominal fine would meet the case. Sir John Bridge imposed a fine of one shilling and costs in respect of each of the six 'buses.

Chelsea Electric Supply Company, Limited *v.* London Electric Supply Corporation, Limited.—In the Court of Appeal on Wednesday, Lords Justices Lindley, Smith, and Davey had before them this case. On August 23rd, Mr. Justice Wright (sitting as vacation judge) made for Mr. Justice Stirling an order restraining the defendants from laying down mains within a statutory area, except in accordance with an agreement between the parties, and from that order the defendants appealed. Mr. Butcher, who appeared for the appellants, stated that the plaintiffs now admitted that the mains as laid by the defendants were in accordance with the agreement, and since the appeal was lodged the parties had come to terms. An order was accordingly made in the terms arranged.

Hope-Jones Electric Organs.—The large organ in the Heaton Parish Church, Bradford, recently mentioned in the ELECTRICAL REVIEW, has been rebuilt on the "Hope-Jones" electric system, by Mr. J. Murgatroyd, of Bradford. The console, which is movable, and the electric action, were manufactured at the Birkenhead factory of the Hope-Jones Electric Organ Company, Limited, where more than 100 men are now employed. Another large four manual organ on this system will be opened at the church attached to the Liverpool School for the Blind, on Advent Sunday. In this case the console and action have been made and fitted by the Hope-Jones Company, while Messrs. Jardine & Co., of Manchester, supply the rest of the work.

Twickenham and Electric Lighting.—A summary of the replies received to the circulars issued with regard to the electric lighting of the area proposed in Mr. Hammond's scheme, has been submitted to the board. The number of circulars issued was 731, number not returned 133, number returned not filled up 168, number returned filled up 430; number in favour of gas 92, number in favour of electricity 274; present annual cost of lighting the houses where electricity is preferred £3,006 10s.; annual amount which the occupiers thereof would be willing to pay for electricity, £3,281 14s.; number of lights required, 5,708. The electric lighting scheme has now been abandoned temporarily on account of the expense.

The Electrical Wonder Company, Limited.—At an extraordinary general meeting of the members of the above company, held at Savoy House, 115, Strand, on November 27th, 1893, the following extraordinary resolutions were duly passed:—"That it has been proved to the satisfaction of the meeting that the company cannot, by reason of its liabilities, continue its business, and that it is therefore advisable to wind up the same." "That the company be wound up accordingly; and that Howard Felgate, of 115, Strand, W.C., be and is hereby appointed liquidator for carrying this into effect."

Huddersfield Electric Lighting.—The Huddersfield School Board has adopted the electric light, which was brought into use at the offices for the first time last Monday evening. The business of the evening was despatched with unusual rapidity, one member suggesting that this was attributable to the electric lighting, but a local paper considers the quick progress was on account of the absence of four out of the fourteen elected officials. If those four individuals were like a certain Taunton councillor for ever standing fast at paltry questions, and causing disturbances, the *Bradford Observer* editor would appear to be correct.

The St. James's and Pall Mall Electric Light Company.—On Thursday the Court of Appeal (constituted by Lords Justices Lindley, Smith and Davey) upheld the decision of Mr. Justice Kekewich of November 1st, who held that the holders of the 100 £100 founders' shares of the company were entitled as divisable profits to the £2,000 set side by the directors in 1891 and 1892 as a redemption fund. The company appealed, and the appeal was dismissed with costs.

Hull Tramways.—At a meeting of the Hull Corporation Electric Lighting Committee held last week, a communication was read from the Electric Construction Company, Limited, referring to the working of tramways by electricity. The company stated that they were prepared to negotiate for the electrical equipment of any line of tramway, and for its subsequent working, and they mentioned that the overhead system had been adopted in South Staffordshire. There was also a letter from Mr. G. F. Priestley, drawing attention to a new type of refuse destructor at work in Halifax, erected especially to raise steam from refuse, and put it to a profitable use, the object in view being for corporations to light their towns with electricity, the fuel used being the town's refuse and dust. Both matters were referred to the chairmen of the Electric Lighting, Sanitary, and Works Committees to prepare a report thereon.

Pontypool and Electric Lighting.—The committee appointed to consider the electric lighting question, reported that the erection of four arc lights of 1,400-candle-power each would cost £94 to erect, and £60 a year to maintain, as against £35 a year, the cost of lighting by gas. If they put a light from dusk to dawn the cost would be £125, an increase of £93 over the present arrangement. The surveyor said that the power of the present lamps at the places referred to was 14 candle-power each, making 224 candle-power, against the 5,600 candle-power, which would be given by the four electric light lamps. A committee have the matter under consideration.

Gilbert & Co.—Last month this firm opened a central station at Cardiff for supplying the Philharmonic Restaurant and other places contiguous with the electric current. They have also put down a further large engine at Messrs. Derry & Toms, Kensington, where the plant is capable of supplying over 100 arc lamps, the majority of which are already working. Messrs. Gilbert have, this summer, increased their works at Hanway Street, and put down plant for the manufacture of dynamos.

Constantinople in London.—Messrs. Benham & Froud are making a number of large brass domes, perforated and lined with ruby, with outer brass work, for covering the arc lamps at the above exhibition, the effect of which, when lighted up, will be very rich. They are also making a quantity of copper, brass and wrought-iron lanterns for incandescent lighting for the streets, bridges, &c., all of original Moorish designs specially prepared for the occasion.

Castleford and Electric Lighting.—At the annual meeting of the Castleford Tradesmen's Association the president suggested that instead of the Local Board disposing of the surplus plant at the disused waterworks, it should be utilised for electric lighting purposes. The Board have had an engineer to furnish them with the estimated cost, so that, doubtless, before next winter the town will be provided with the electric light.

Appointments.—Mr. Cuthbert Moore was recently appointed electrician on board the P. & O. steamship, *Ganges*.—Mr. D. Bergin has been appointed electrician in the White Star Line.—Mr. W. C. Thomson has been appointed second engineer to the Westminster Electric Supply Company, Eccleston Square Station.—All three qualified themselves as electrical engineers under Mr. Ronald Scott, of Acton Hill, W.

Dover Electric Lighting.—At the invitation of the Mayor a large meeting of ratepayers and others was held at Dover last week to hear an address by Mr. Sellon of the Brush Electrical Engineering Company, relative to the formation of a local electric lighting company. It seems that the idea was to ascertain what amount of support the company would receive from the public.

Agency.—The Partington Advertising Company have just entered into an agreement with the Electrical Advertising Syndicate, Limited, making the Partington Company sole agents in London for the sale of electric letters. We have received from the syndicate a pamphlet descriptive of their electric letters and tablets for advertising.

The Electric Lighting of Hammersmith.—At the last meeting of the Hammersmith Vestry it was decided to instruct Messrs. Morgan, Williams & King, of Westminster, to prepare a report for carrying into effect the terms of the Provisional Order recently obtained for the sum of one hundred guineas.

Mevagissey and Electric Lighting.—The vestry having received from the lighting committee estimates of the cost of lighting the town with oil, gas, and electricity, have resolved to adopt electric lighting, but the matter is deferred until Parish Councils have been formed.

Correction.—In our list of Sunderland electric light tenders last week, we stated that Messrs. C. A. Parsons & Co.'s total estimate for the same is £19,044. We are asked to correct this to £14,052, which was the amount of their tender for the whole.

Medical Battery Company, Limited.—The first meeting of contributories takes place to-day at 3 p.m., at 33, Carey Street, Lincoln's Inn, W.C., and that of creditors is to be held at 11 a.m., at the Holborn Restaurant, also to-day.

Aladdin Primary Electric Battery Company, Limited.—A petition has been presented for winding up the above company. The petition was presented on 28th ult., and is to be heard at the Law Courts on December 19th.

Market Lighting.—A proposal has been before the Standing Committee of the Borough Market Trust to light the Borough Market by electricity, but the committee have decided not to entertain the idea at present.

Woking Lighting.—The Local Board are enquiring of the Woking Gas Company and the Woking Electric Supply Company, their price for 100 public lamps in Woking Station and Maybury Ward, to be alight from sunset to midnight, the company selected to keep them in proper order for 12 months, and to give the Board the option of purchasing the lamps.

Dover and Electric Lighting.—The seal of the Dover Corporation has been affixed to the transfer of the provisional order for electric lighting from the Town Council to the Dover Electric Lighting Supply Company.

The Lighting of Oriel College, Oxford.—The electric lighting of the above college has been entrusted to Messrs. Girdlestone, Tatham & Co.; the work will be carried out during the Christmas vacation.

Morecambe Electric Lighting.—It has been decided to increase the subscribed capital of the Morecambe Electric Light and Power Company, Limited, and about 1,000 additional shares have been taken up.

Electric Light in Burnley.—The charge for electricity in Burnley is to be at the rate of 4d. per Board of Trade unit. The applications now in hand are for 3,434 lamps of 8 candle-power.

Electric Lighting in Aberdeen.—Last week the members of the Gas Committee of the Aberdeen Town Council inspected the new electric lighting station in Cotton Street.

Richmond and Electric Lighting.—Messrs. Kempthorne & Phillips have had fitted two brilliant arc lamps in their premises in George Street.

CITY NOTES.

Elmore's French Patent Copper Depositing Company.

MR. C. J. STEWART (Official Receiver and Provisional Liquidator) last week issued his summary of the affairs of the above-named company, from which we extract the following:—

The company was incorporated September 10th, 1890, and was formed for the purpose of acquiring and working in France certain French patents relating to an improved process for manufacturing copper articles discovered by Messrs. F. E. and A. S. Elmore, and patented by them in or about the year 1885. In the year 1889 a company was formed to acquire and work their patents relating to Great Britain and Ireland. At the date of the formation of the company Elmore's Foreign and Colonial Patent Copper-Depositing Company, Limited (referred to hereafter as the Foreign and Colonial Company), were the owners of all the existing patents for other parts of the world than Great Britain and Ireland relating to the Elmore copper process. On September 4th, 1890, the Foreign and Colonial Company agreed with Woodhouse and Rawson United, Limited, now in liquidation, that the latter company should form a company for the purpose of acquiring the patents for France relating to the Elmore copper process in consideration of £15,000 in cash, the whole of a premium of 10s. on each of 51,750 shares if subscribed for by the public, and half of a like premium on any further number of shares allotted to the public. The benefit of this agreement was transferred by Woodhouse & Rawson United, Limited, on September 9th, 1890, to the Phœnix Trust Company, Limited, which company appears to have actually promoted the French Elmore Company. On September 10th, 1890, the French Elmore Company agreed to purchase from the Foreign and Colonial Company the French patents above mentioned for the sum of £83,500 in cash, £66,500 in the form of 33,250 £2 shares credited as fully paid up, and the premium of 10s. on each share subscribed for by the public. This agreement was duly carried out; the purchase price paid to the vendor company was £183,375, of which £66,500 was in shares and £116,875 in cash. A prospectus was issued to the public in the month of September 1890, containing extracts from various reports speaking in favourable terms of the Elmore copper process, and the whole of the original capital of £66,750 offered to the public was at once subscribed for, and was allotted on September 19th and September 22nd, 1890.

The original directors of the company were Major Charles Jones, Sir James D. Mackenzie, Bart., Sir Richard J. Meade, Messrs. E. J. Carson, William Elmore, and C. G. Philips. The board has varied by the resignation of Mr. C. G. Philips on February 1st, 1892, of Mr. W. Elmore on August 10th, 1892, and of Sir R. J. Meade on December 24th, 1892, and by the death of Mr. E. J. Carson on June 25th, 1893. M. G. C. V. Holmes joined the board on October 1st, 1890, and resigned on April 23rd, 1892. Messrs. E. J. Carson, W. Elmore, and G. C. V. Holmes were also directors of the Foreign and Colonial Company. Mr. F. L. Rawson, a director of the Foreign and Colonial Company, of Woodhouse & Rawson United, Limited, and of the Phœnix Trust Company, though not a director of the Elmore's French Company, appears to have frequently attended the board meetings, and to have exercised great influence in the management of the affairs of the company. By a resolution of the board, dated September 22nd, 1890, it was agreed to join with other companies formed to work the Elmore copper patents in other countries in taking a common office. Such office has been as follows:—From the date of incorporation till November 20th, 1890, 20, Bucklersbury, E.C.; from that date till April 24th, 1893, 64, Cannon Street, E.C.; and from that date till the winding-up order, Suffolk House, Laurence

Pountney Hill, E.C. The secretary of the company, Mr. James Shurmer, has also been secretary to Elmore's (English) Patent Copper Depositing Company, Limited, the Foreign and Colonial Company, Elmore's Wire Manufacturing Company, and the American and Canadian Patent Copper Depositing Company. A contract was entered into on September 26th, 1890, between the Rhone Land and Water Power Company, Limited, and Elmore's French Company (adopting a previous agreement, dated September 10th, 1890, between the Rhone Land and Water Power Company and Major Charles Jones, acting as trustee on behalf of Elmore's French Company), whereby the latter company undertook to purchase for £5,000 six acres of land at Bellegarde, belonging to the Rhone Land and Water Power Company, and to pay a rent of not less than £3,000 per annum, from October 1st, 1891, for the supply of water power. On October 1st, 1890, M. Secrétan, a French expert in metallurgy, was appointed manager of the company in France, and on October 6th, 1890, a committee of management in France, consisting of MM. Vigreux, Chevallier, Bourdon, Chierrière and Vilbot, was appointed to act with M. Secrétan in the management of the company's affairs in France. In the month of November, 1890, the board resolved, apparently upon the strength of representations made to them by M. Secrétan, that it was advisable that works for the manufacture of copper should be erected in the north of France, on a much larger scale than had been contemplated at Bellegarde, and on December 12th, 1890, it was decided that certain land, amounting to about 37 acres, at Dives, near Havre, should be acquired for that purpose. Tenders were invited in France for the construction of the works thereon, and it was resolved on January 6th, 1891, to accept contracts to erect the buildings and to furnish the same with all necessary machinery at a cost of about £90,000 (2,250,000 fr.). In order to meet their increased outlay an agreement was made on October 29th, 1890, with the Foreign and Colonial Company to issue to the latter company debenture stock for £50,000 at 6 per cent., redeemable at £105 on November 1st, 1893. In pursuance of this agreement, the Foreign and Colonial Company appears to have advanced £50,000 to the company in various sums as required. The debenture stock for the most part seems to have been taken up by the shareholders of the Foreign and Colonial Company. The payment for all expenditure in France, including the cost of the erection of the buildings and the machinery at Dives, was in the hands of M. Secrétan and the Paris committee, who drew upon the company's bankers in France, the latter being supplied from time to time with funds from the London bank of the company. No accounts in detail of such expenditure appear to have been furnished to the board in England, but the books in France were audited annually by Messrs. Deloitte, Dever Griffiths and Co., the company's auditors, and a summary of the assets and expenditure in France was supplied to the board, and included in the annual balance-sheets. The directors seem to have disregarded the suggestion of the auditors that the total of the cash-book expenditure should be initialled by M. Secrétan as an indication of his approval of the payments made. It was stated by M. Secrétan at the first general meeting of the shareholders, on January 9th, 1891, that works constructed to produce 370 tons of copper articles per month would commence manufacturing on July 1st, 1891, and would at the end of three months have reached their full production. In consequence, as it is represented, of defects in the soil on which the works were being constructed, and of the difficulty in finding suitable machinery for working the Elmore copper process, which necessitated a considerable expenditure of time and money in experiments in order to discover such machinery, the cost of the works largely exceeded the original estimate, and the manufacture of copper articles for sale does not seem to have commenced until April, 1892, between which date and December 31st, 1892, the total sale of such articles was under 100 tons.

At a general meeting of shareholders on April 22nd, 1892, it was decided to increase the capital of the company by the creation of 100,000 preference shares of £2 each, to be entitled to a priority on a distribution of assets, and to a preferential dividend of 10 per cent., and to a further dividend of 5 per cent. after a dividend of 15 per cent. should have been paid on the ordinary shares. In pursuance of this resolution a prospectus was issued on April 23rd, 1892, offering 60,000 such shares for subscription, of which 40,000 were reserved for the holders of ordinary shares of the company and 20,000 were offered to the public. The same prospectus stated that the interest of 10 per cent. was guaranteed for one year by the Foreign and Colonial Company. On July 16th, 1892, of the issue of 60,000 shares, only 13,250 had been applied for and allotted, and on that day another prospectus was issued, offering for subscription on the same terms 20,500 preference shares, forming part of the above mentioned 60,000 shares, and on November 19th, 1892, a circular was sent to the shareholders in the Elmore companies offering 10,000 preference shares on the same terms. The total number of preference shares allotted is 22,516, on which £44,707 has been paid, and £325 remains due on unpaid calls. The company has from time to time borrowed considerable sums of money, of which the largest were advanced by the Foreign and Colonial Company, which, being interested in the prosperity of the company, assisted it financially in various ways, and pledged some of its own securities in order to secure loans made to the company by others. On April 2nd, 1892, the company being largely in the debt of the Foreign and Colonial Company, executed to that company a mortgage of the whole of its property in France for the sum of £95,000, of which the first £50,000 was declared to be held in trust for the holders of the existing debenture stock holders above mentioned. At a general meeting of the debenture stock holders on February 20th, 1893, the directors were empowered to issue new debenture stock to the amount of £100,000, bearing interest at the rate of 7 per cent. Circulars were accordingly issued stating that it was proposed to extinguish the existing debenture stock of £50,000 by conversion or redemption, and offering for subscription £65,000 of the new issue; it was also stated in the circulars that unless £30,000 of the new debenture stock should be subscribed for in cash at par within two months no allotment should be made. The secretary states that applications were received for only £8,533, on which £2,747 8s. was paid; this amount was placed to a separate account at Martin's Bank, and has not been returned in the statement of affairs, an injunction having been granted by the High Court restraining Martin's Bank from parting with the same. The applicants for the stock are apparently entitled to a return of the moneys. The whole of the company's monetary resources were exhausted in connection with the establishment of the works in France, and it was unable to meet the interest falling due upon the debenture stock on November 1st, 1892; under the powers contained in the debentures, Mr. J. H. Duncan was appointed as receiver on behalf of the holders thereof on March 28th, 1893, his appointment being confirmed by the Court on April 14th, 1893. The company being unable to continue its business, an extraordinary general meeting of the shareholders was held on May 8th, 1893, when it was resolved that the company should be wound up voluntarily, and that Mr. F. W. Pixley should be the liquidator. On the same day, at an ordinary annual general meeting of shareholders, a resolution was passed approving of an agreement, dated April 29th, 1893, by which Mr. Duncan, as receiver for the debenture-holders, agreed to sell to M. Secrétan the company's works, patents, and business in France, the land at Bellegarde being excepted. The terms of this agreement for sale were as follows:—M. Secrétan to form and register in France a new company, with a capital of 2,500,000 fr., divided into 5,000 shares of 500 fr. each, of which 1,000 were to be allotted to him as fully paid, and 4,000 were to be offered for public subscription. M. Secrétan to satisfy all French creditors and shareholders, and take over all assets, including book debts, connected with the works at Dives; that he should receive from the new company in France, and hand over to Mr. Duncan, 5,000 founders' shares, of no specified face value; that he should also receive 245,000 fr. from the new company in cash, of which he should retain 30,000 fr., and hand over the balance of 215,000 fr. to Mr. Duncan; and that he should receive and hand over to Mr. Duncan 3,000 obligations (debentures) of 500 fr. each, secured by mortage upon the works at Dives. The sale is now in course of completion. No dividends have been paid on the ordinary shares. The dividend of 10 per cent. on the preference shares, which was guaranteed for one year by the Foreign and Colonial Company, appears to have been paid by that company.

The following is a summary of the statement of affairs at the date of the winding-up order, which is submitted by Mr. Shurmer, the secretary, and is concurred in by Major Jones and by Sir J. D. Mackenzie, the directors of the company:—

(I.)—AS REGARDS CREDITORS.

Gross liabilities.	Liabilities.		Expected to rank.
	Debts and liabilities, viz.:—		
£12,017	Unsecured creditors		£12,017
76,082	Creditors partly secured	£76,081 19 7	
	Less estimated value of securities, viz.:—Balance of assets, as per contra . £22,892 15 10		
	Debentures mentioned below 11,900 0 0		
		34,792 15 10	
	Estimated to rank for dividend...		41,289
52,361	Loans on debenture bonds and interest, deducted contra, of which £11,900 are held by creditors partly secured	£52,360 15 5	
	Preferential creditors for rates, taxes, wages, &c.		152
£140,460			£53,458

Assets.		Estimated to produce.
Cash at bankers		£54
Other property, viz.:—		
Purchase money due on sale of company's undertaking at Dives		73,600
Land at Bellegarde		1,000
Book debts, viz.:—		
Good		2
Doubtful	£944 8 2	
Estimated to produce		472
Unpaid calls	£325 0 0	
Estimated to produce		125
Estimated total assets		£75,253
Deduct loans on debenture bonds and interest, secured on the assets of the company, as per contra		52,360
Balance of assets carried to contra		£22,892
Estimated deficiency of assets to meet liabilities of the company, subject to cost of liquidation		£53,458
		£53,458

(II.)—AS REGARDS CONTRIBUTORIES.

Capital issued and allotted, viz.:—		
33,250 ordinary shares of £2 per share, allotted to vendors as fully paid ...	£66,500 0 0	
66,750 ordinary shares of £2 per share, allotted to the public (819 shareholders).		
Amount called up at £2 per share	133,500 0 0	
22,516 preference shares of £2 per share, allotted to the public (346 shareholders).		
Amount called up at £2 per share	45,032 0 0	
	£245,032 0 0	
Less unpaid calls estimated to be irrecoverable	200 0 0	
		£244,832
Add deficiency to meet liabilities as above		53,458
		£298,290

Total deficiency ... ... £298,290.

Among the unsecured creditors are included four directors, whose claims in respect of fees amount to £798 7s. 8d. The claims of the creditors partly secured (£76,081 19s. 7d.) include one of £27,000 by three persons who hold as security £11,900 debenture stock of the company and collateral security of the Foreign and Colonial Company; they appear to have advanced £23,000 to the company in December, 1892, and received the company's acceptances for £27,000, payable at intervals until February, 1894, the balance of £4,000 being charged as interest at an average rate of 18 per cent. There is also included a claim of Elmore's American and Canadian Patent Copper-Depositing Company, Limited, for cash lent to the company between October, 1892, and February, 1893, amounting to £7,261 17s. 4d., to secure which it holds a first charge for £2,000 upon the whole of the company's property, in addition to collateral security of the Foreign and Colonial Company. The other credi or partly secured is the Foreign and Colonial Company, which holds a mortgage registered in France upon the whole of the company's property for £95,000 (subject only to the charge of £2,000 above mentioned), the first £50,000 of which is held in trust for the debenture-holders. The sum now due in respect of advances upon this mortgage, over and above the amount so held in trust, is returned as £41,784. Of the £50,000 debenture stock issued as above mentioned, in pursuance of the resolution of October 29th, 1890, £12,000 appears to have been redeemed by the company in December, 1892, of which £100 was cancelled and £11,900 transferred as collateral security to the three partly-secured creditors, as before stated. The liability upon debenture stock is thus £49,900, with interest due thereon to the amount of £2,360 15s. 5d. The land at Bellegarde, for which the company paid £5,270, is now estimated to produce £1,000. The chief item among the debts due to the company returned as doubtful is a debt of £900 due from the Phœnix Trust Company, now in voluntary liquidation. Some difficulty has been experienced in investigating the company's transactions with respect to bills, which have been of considerable magnitude. One bill-book has been used in common by all the Elmore companies, and the Official Receiver has not been able to obtain possession of it. The correspondence also of all the Elmore companies has been kept on a common file. No seal register was kept by the company.

The following is a summary of the deficiency account contained in the statement of affairs:—

Deficiency as per statement of affairs	£298,290 15 8	
Premiums received on ordinary shares	33,375 0 0	
Forfeited deposits on ordinary shares	8 0 0	
Amount to be accounted for		£331,673 15 8
Expenses of carrying on business during the existence of the company		£38,776 2 1
Bad debts		472 4 1
Directors' fees during existence of company ...		3,616 13 4
Depreciation of property not written off in company's books		254,351 9 8
Other losses and expenses during existence of company, viz.:—		
Loss on trading		7,813 14 3
Expenses of issue of preference shares		3,384 9 7
Preliminary expenses		18,989 2 8
Land at Bellegarde, France, cost	£5,270 0 0	
Less estimated present value	1,000 0 0	
		4,270 0 0
		£331,673 15 8

M. Secrétan was appointed by the board as manager in France at a salary of £1,200 per annum for the first two years, at the expiration of which period his remuneration was to be 20 per cent. on the net profits of the company. The remuneration of the Paris Committee was fixed at £800, to be divided among its members as they thought fit. The "interest on loans" includes a bonus of £3,000 credited to the Foreign and Colonial Company, by direction of the board in recognition of past services in assisting the company with funds. This sum is contained in the £41,784 1s. 4d., returned as secured by the French mortgage for £95,000 as above stated.

The directors' fees (£3,616 13s. 4d.) include annual payments of £400 to the chairman, £300 to the vice-chairman, and £200 to each of the other directors, in pursuance of the articles of association. Of the above sum £798 7s. 8d. remains unpaid. The purchase of patents (£173,875) represents the price paid to the vendor company, £183,375, less £9,500, the net sum received for the sale of a license to manufacture and sell in France parts made by the Elmore copper process. The expenditure on works at Dives (£137,263 18s. 4d.) includes the following items:—Purchase of land, £5,951 4s. 1d.; factory buildings and cottages for workpeople, £46,808 5s. 8d.; machinery, tools, &c., £83,005 2s. 10d. The Paris office general account (£16,202 1s.) represents the expenditure on certain stock and other assets in France up to December 31st, 1892. The loss on trading (£7,813 14s. 3d.) is made up of £5,187 6s. 1d., the balance of loss, as shown in the manufacturing account, between June 1st and December 31st, 1892, appended to the balance-sheet for 1892, and a sum of £2,626 8s. 2d., which includes expenditure in France affecting the working during the same period, less sundry receipts for rents and transfer fees, &c.

The "expenses of issue of preference shares" (£3,384 9s. 7d.) include for postages, printing, and advertising, £2,926.

The failure of the company is attributed by the secretary to the fact that the works were undertaken on too large a scale in proportion to the capital; it was intended to raise more capital later when the merits of the Elmore copper process had been proved; but this had not been done by the time the additional capital was required, and, consequently, the preference shares were not subscribed for to the extent that had been hoped.

The first meetings of the creditors and shareholders of this company were held on Tuesday last at the Holborn Restaurant, under the chairmanship of Mr. C. J. Stewart, Official Receiver.

The company was formed in September, 1890, for the purpose of acquiring and working in France certain French patents relating to an improved process of manufacturing copper articles discovered by Messrs. F. E. and A. S. Elmore, and patented by them in or about 1885. A winding-up order was made against the company last July upon a creditor's petition, and accounts have been filed showing total liabilities £140,460 5s. 3d., of which £53,458 15s. 8d. are expected to rank for dividend. The assets, valued at £75,253 11s. 3d., are absorbed by the claims of the debenture holders and the partly secured creditors, whilst the account with the contributories show a total deficiency of £298,290 15s. 8d.

In presiding at the creditors' meeting, the CHAIRMAN said the business actually to be transacted was the appointment of a liquidator and committee of inspection. The observations upon the case had already been sent round to the creditors, therefore he did not propose to deal with them in detail, but if there was any further information required, he would be pleased to give it. He had asked Mr. Duncan, who had been appointed as receiver on behalf of the debenture holders, to attend in order to explain the company's present position and the circumstances relating to the sale of the property. The directors in attendance were Sir J. D. Mackenzie and Major Jones, and Mr. James Shurmer, the secretary to the company, was also present. He (the chairman) had been asked by the directors to point out that although the accounts showed a sum of £3,600 in respect of directors' fees, only £3,000 had really been paid to the directors, about one-half being paid in cash and the remainder in preference shares. Further, it was only fair to state that the directors had lent £1,440 to the company.

Mr. DUNCAN next addressed the meeting. He thought that most of the persons present had some knowledge of the scheme that had been worked out with the debenture holders. The property had been sold to M. Secrétan, who had in turn transferred it to a French company. The property sold did not include the Bellegarde land or the London assets. The consideration was £8,600 cash, £60,000 in first mortgage French obligations, and 5,000 founders' shares, which were entitled, as a dividend, to £4,500 in cash, and one-half of the residue left after paying the interest on the new share capital to be raised in France. The cash part of the purchase money had already been received. A difficulty had arisen in the completion of the sale owing to the form of the debenture bond, and that had caused a considerable amount of trouble, as they wanted a bond in consonance with English ideas, and yet one that would be saleable on the French market. Under those circumstances he could hardly say at that meeting whether they could complete within 10 days, but they certainly hoped to do so. A scheme of distribution had also been worked out, and the majority of the debenture holders had given their assent to it. It was very necessary to obtain such assent, as at the present moment the debenture holders had security over the whole assets of the company, and could realise them to pay their claims. He estimated those claims would amount to £56,000. Many of the debenture holders being also shareholders, had met him in a most conciliatory spirit, and it was hoped that not only would the scheme allow something to go to the creditors, but also leave some remnant in the future for the shareholders. The arrangement provided for the debenture holders being satisfied with paper instead of cash. They were to take 5 per cent. in cash as a bonus, but the claims were to be paid in paper of the new French company at par, plus interest to the end of the year. The next point dealt with by the scheme was the claim of the Foreign and Colonial Company, who had advanced £40,000 on a second mortgage. Steps had been taken to get rid of that claim by giving them six per cent. second debentures, and allowing the ordinary creditors to rank next to the debenture holders. The Foreign and Colonial Company were the promoters of the French company, and on that account it was thought they ought to make some concession. That had been made by deferring their claim until after the ordinary creditors, who would receive 6 per cent. first debentures. They were some of the details of the scheme, but it would be necessary to take another journey to Paris before the final settlement could be made. The question for the creditors to decide at a later meeting was, whether they would accept the arrangement,

The CHAIRMAN said the outcome of the whole scheme appeared to be that all that the creditors could count upon in any way was a first mortgage in the resuscitated French company on 5,000 founders' shares, £3,000 or £4,000 worth of obligations, and a small amount in cash. Of course, the position of affairs was that there was practically no surplus on the sale, and it appeared to be a case in which it was better to have a few crumbs than no loaf at all. The only point to discuss was, if the creditors were of opinion that the scheme was a satisfactory one, it would be advisable for them to appoint Mr. Duncan, who was receiver for the debenture holders, as liquidator to carry it out.

After a slight discussion, Mr. DUNCAN suggested that the meeting should be adjourned for a fortnight, to enable the scheme to be completed and laid before the creditors. The suggestion was cordially approved, and the meeting was accordingly adjourned to the 20th inst. It was further stated that a meeting of the debenture holders would be held under the Joint Stock Companies Arrangement Act on the same date at an earlier hour.

The meeting of shareholders was numerously attended.

Mr. STEWART, the official receiver, commenced by saying that with regard to the directors' fees, it was only fair to those gentlemen to point out that of the amount paid to them, £1,500 was in cash and £1,500 in preference shares; whilst, on the other hand, they had lent £1,440 to the company, so that the net amount actually received by them was very small. As to his statement with regard to Mr. Rawson, he did not mean to imply that he had exercised great influence in the management of the company's affairs, but rather that he had exercised great influence in the financial affairs of the company, having raised large sums of money for them at reasonable rates of interest, but that he had nothing to do with the management or the spending of the large sums that he has raised. Mr. Rawson had sent him a very full statement to verify, and Mr. Rawson would no doubt give the meeting particulars of what he had done. He explained that the delay in holding the meeting was due to the fact that the statement of affairs was not submitted until last October. As the shareholders had already been furnished with his observations, he did not propose to comment upon them at any length. It was necessary, however, to draw attention to the cause given for the company's failure, which was attributed by the secretary to the fact that "the works were undertaken on too large a scale in proportion to the capital. It was intended to raise more capital later when the merits of the Elmore copper process had been proved; but this had not been done by the time the additional capital was required, and consequently the preference shares were not subscribed for to the extent that had been hoped." He wished the shareholders to bear in mind the original cost of the patents, &c., to the company. The price paid for them by the company was £183,375, of which sum £116,000 was actually paid in cash. To that outlay had been added an expenditure on the works to the amount of £137,263, thus making the total cost of the patents and works £320,638. From that amount, however, ought to be deducted a sum of £9,500 received in respect of a patent for the manufacture of copper pans, which reduced the total amount to £311,138. That did not include a further sum of £17,000 spent upon improvements and experiments. In spite of that large expenditure, the best price that could now be obtained for them was £73,500, payable in cash, and certain obligations and founders' shares. He was informed, and had no reason to doubt the accuracy of the information, that the best offer that could be obtained in *cash* for the works and patents was about £20,000, which did not compare very favourably with the amounts actually expended upon them by the company. Having commented upon the preference shares, and a guarantee given by the Foreign and Colonial Company in connection therewith, the Chairman said that one great difficulty in attempting to unravel the affairs of the company, and also that of Woodhouse & Rawson, Limited, was that all the affairs were practically conducted in one office. The correspondence was all mixed up together, and one gentleman had acted as secretary of the different companies. The observations had reference to M. Secrétan, who was appointed by the board as manager, and also to the large amount of expenditure incurred in France. It was only fair to state that M. Secrétan appeared to have drawn the directors' attention to the fact that a very large expenditure was required on the works in order to obtain a satisfactory result, and so far as it could be traced, that gentleman's estimate of the amount actually required had not been exceeded. It would be for the directors to explain their reasons for expecting that financial assistance which was necessary to place the works in a position to yield a satisfactory return to the shareholders. The deficiency account showed that the interest charged upon loans amounted to £14,233, and that part of the money had been borrowed at a very high rate of interest. With regard to that portion of the money borrowed at an average rate of 18 per cent., it was only fair to state that Mr. F. L. Rawson denied having anything to do with those advances, or that he had secured any financial assistance at that rate of interest.

Mr. F. L. RAWSON next addressed the meeting, and replied to the Official Receiver's statements generally. He pointed out that some of them might be misunderstood by the Press. The Official Receiver did not intend to infer that the affairs of Woodhouse & Rawson United and the Elmore Companies were in any way mixed; but that the Elmore Companies, in order to save expense and avoid confusion, had one office, one secretary, and kept their papers together.

Mr. STEWART repudiated any intention to say that the affairs of Woodhouse & Rawson United were at all mixed with those of the Elmore Companies.

Mr. RAWSON, continuing, said he would like to correct another impression that might have been given to the Press, viz., that £20,000 was the best offer that could be obtained. It was the largest amount in *cash* which in any of the later negotiations was offered; but debentures, founders' shares, and other securities were from time to time offered in addition. At the Official Receiver's request, he would give them a short account of his connection with the company. After the formation of the company, it was proposed that M. Secrétan should be appointed as manager. That gentleman stipulated that £80,000 should be spent on the works alone. The directors thereupon asked him (Mr. Rawson) to attend a board meeting, when the officials of the English Elmore Company stated that that company would be turning out and selling 20 tons per week in three months. Upon that he advised the directors that if this were the case, his knowledge of the process justified him in saying, that he would provide any reasonable amount of money required at 7 per cent. per annum. Circumstances had since justified him in the opinion he then stated. He thereupon got £50,000 of first debenture stock of the company taken at par, bearing interest at the rate of 6 per cent. per annum, of which he himself placed £18,000. During the first two or three months he gave a large amount of time to looking after the patents, which as all were aware, are kittle cattle to deal with. The company, however, had never had a day's trouble with regard to their patents from that time to the present. He practically had nothing more to do with the company until November 20th, 1892, when he was asked to attend a general meeting of all the Elmore directors, which had been called to consider what could be done to help the French company, which owing to the delay of the English company was in a perilous plight financially. Only one director attended that meeting, and he (Mr. Rawson) thereupon took the finances of the French company in hand, and from that day until the middle of July the minute book of the company showed that he was thoroughly successful, and that the company, with his assistance, was able to borrow what was necessary at low rates of interest. In July he stated to the directors that if they would turn out 20 tons per week for 12 consecutive weeks, he would obtain for them £100,000 on reasonable terms, and they informed him that they required £30,000 to do that. He thereupon got practically all the debenture stock holders to agree that if Sir Frederick Bramwell and Mr. Harris reported confirming the statements that he had made, they would allow the company to borrow £30,000 secured on the freehold in advance of them. Messrs. Bramwell & Harris made a report on July 8th, amply confirming the statements. Subsequently Lord Farrer, Mr. Wood, Mr. Holland (Lord Knutsford's son), and several of the largest shareholders agreed to guarantee the loan with him, and he obtained an offer of £30,000 from one of the Trust Companies for 12 months, paying them 8 per cent. per annum. The directors, however, were offered £50,000 at 6 per cent. per annum by other parties, and declined his offer, whereupon he withdrew, having, in all, obtained for the company over £100,000 at an average rate of less than 6 per cent. per annum, and having successfully carried out all that he had promised to do after working for many months until past midnight. He had no knowledge of the negotiations during the next few months, but at the latter end of the year he was requested to help the company to get the parties to sign the proposed contract. In that he was successful, but, at the same time, he told the directors that he did not think it would be carried out. It happened that the parties failed to carry out the contract, and the directors were obliged to borrow £20,000 at the high rate of interest referred to by the Official Receiver. What he did then was to get some small advances at reasonable rates, and help to negotiate the sale of the business in France, and had it not been for the proceedings of certain parties well known to most of those present, the sale would have been carried out on better terms than had now been arranged, and the company would never have gone into liquidation. With regard to the terms of the present sale, which were not quite as good as those he had read out to the shareholders some months ago, when he was in negotiation with parties in France, still, looking at the sale as a method of raising working capital in France, the position of the ordinary shareholders was not much worse. If M. Secrétan made £50,000 per annum, as he had publicly stated, it would work out to over 4 per cent. interest on the ordinary share capital of the company. The affairs of the company had been investigated, and the part taken by him would now be seen by the shareholders, but he had sent in a full statement to the Official Receiver, giving all particulars and details, so that he could check his (Mr. Rawson's) statements, and confirm them.

The CHAIRMAN next invited Mr. Duncan, the receiver for the debenture holders, to acquaint the shareholders with the actual position of the company, and especially as to the sale of the property.

Mr. DUNCAN said he had already sketched the lines of the sale, viz., £8,600 in cash, £60,000 in debentures, and £5,000 founders' shares. They had gone a step beyond selling the property, and had been trying to work out a scheme of arrangement, under which something might be saved for the shareholders. The main point of interest to the meeting was the fact that there was a provision by which the debenture holders would consent to receive payment in French paper for the full amount of their claims, plus interest, at par value, whilst the ordinary creditors would also consent to take payment in debentures of the resuscitated company. They proposed that all proceedings appertaining to the liquidation should be cancelled, and the company continue to exist, and be in a sense a trust company to receive the results from Paris for distribution amongst the preference, and afterwards the ordinary shareholders. A further point was that the Foreign and Colonial Company would postpone a claim of £50,000 until the ordinary shareholders had received 5 per cent. It was still possible they (the shareholders) might receive something upon their shares, although it was utterly impossible to hazard any statement as to a definite sum, although he saw no reason to differ from the statement put forward by Mr. Rawson with regard to profits. The scheme had taken several months to elaborate, and was well worth the trouble that had been taken in the interest of the shareholders. It was evident that the English company would always have worked the business in France at a manifest disadvantage, and that the French company would be in a much better position to treat with the French Government and other bodies, and he thought

that ultimately the half they would now get, would be more than the whole they would have received as an English company, considering the present Chauvanistic state of matters in France.

A SHAREHOLDER enquired the amount of copper that was now being turned out by the company.

In reply, Mr. DUNCAN said it was not advisable to state figures at that meeting, and he did not think it would help matters much if he gave the information. It was sufficient to say that M. Secrétan's expectations had been pretty well realised. He further stated that, if it were possible, some particulars would be sent to the shareholders of the proposed scheme before the 20th inst.

The CHAIRMAN then drew the attention of the meeting to the formal business, viz., the appointment of a liquidator, and suggested that if the shareholders approved the scheme, the better plan would probably be to appoint Mr. Duncan as liquidator to carry it out.

Mr. MADDISON stated that a meeting of the debenture-holders would be called under the Joint Stock Companies Arrangement Act to finally settle and approve the scheme, which could then be laid before an adjourned meeting of the shareholders in a definite form to be discussed and voted upon.

A resolution to adjourn the meeting to the 20th inst. was then put to the meeting and carried.

Mr. STRETTELL asked to be informed of the total amount of commission paid to Mr. Rawson for his assistance rendered to the company and for obtaining the loans.

Major JONES (the late chairman): Not one penny.

The CHAIRMAN said that no payment appeared to have been made to Mr. Rawson in that behalf.

Mr. RAWSON added that he had not only received no commission from the company, but the directors, having given him a call for 12 months on £10,000 preference shares at par for services rendered, he handed over the majority of the call to a company that he considered had been badly dealt with by the Elmore companies, and he returned the balance to the company.

A vote of thanks to the chairman terminated the proceedings.

La Compagnie Française des Télégraphes Sous-marins.

IN the report of this company, the directors state that, despite certain unfavourable circumstances, now passed, the development of the company was continued during 1892, as, on the one hand, the receipts were 400,000 francs more than in the previous year, and, on the other, a new concession of over 1,500 kilomètres was considered and obtained at the beginning of 1893. After referring to the political troubles in Venezuela and other matters, the following paragraph is devoted to the Azores cable: On the demand of the French Government, in March last, we opened negotiations at Lisbon with a view of obtaining exclusive rights of landing at the Azores, in exchange for the establishment of a cable connecting Lisbon with those islands. After a severe struggle with the English companies, and after a competition opened for the establishment of the cable, an engagement was signed between us and the Portuguese Government, whereby we undertook to establish the cable from Lisbon and the Azores within a year, counting from April, 1893. Per contra, Portugal granted us, for 25 years, exclusive rights of landing all cables connecting the Azores and North America and the European continent. In March last the French Budget Committee expressed an unfavourable opinion to the project, and by a letter dated March 24th, 1893, the Minister of Commerce, in announcing the decision of the Budget Committee, stated that under these circumstances it was not possible to secure the ratification of the project, and that was the definite check of the Azores proposal. Referring to the New Caledonian cable, the report says that the construction of the cable was entrusted to the Société Générale des Téléphones, and was finished on June 5th, under conditions of remarkable rapidity. The New Caledonia cable, 828 marine miles long, was constructed in less than two months and a half. After a reference to various other proposed extensions, &c., the report concludes: The receipts of the current year were, for the first four months, 329,707 francs against 261,217 francs for the same period of 1892. By the terms of the statutes, a director retires this year, and that director is M. Lefaivre, whom we propose to re-elect. When you have heard the report read, we shall propose to you (1) to approve the accounts for 1892, as presented to you, carrying over to the profit and loss account the sum of 72,640 francs; (2) to re-elect as a director M. Lefaivre, whose term of office has expired; (3) to name the account commissaires, and fix their remuneration.

The Hove Electric Lighting Company, Limited.

THE first report of the directors, to be presented at the annual general meeting of the shareholders at the Town Hall, Hove, in the County of Sussex, on Tuesday, December 12th, 1893, at 3 o'clock p.m., states that by the terms of the contract with the Hove Commissioners, approved by the Board of Trade, it is stipulated that the first annual balance-sheet of the company shall be made up to December 31st, 1893, but under the articles of association a general meeting of the company must be held in each year, when accounts made up to the latest convenient date have to be presented to the shareholders. With the view of complying with this latter requirement, the directors now lay before the shareholders a balance-sheet and profit and loss account made up to September 30th last, duly audited, and which they propose shall be considered merely as an interim statement, to be superseded early next year by the accounts up to December 31st next, prepared in the form required by the Board of Trade. It will be seen from the accounts attached to this report that the result of working up to September 30th, after debiting to revenue a proper proportion of the administration charges from January 1st, when the lighting was practically commenced, is a debit balance of £264 10s., a result which, in a new enterprise, must be considered as satisfactory. Since about the middle of September, the working account shows a steadily increasing net profit each week, and the balance at the debit of the profit and loss account on September 30th has since been reduced considerably, and the directors have every reason to anticipate that this balance will soon disappear. The contract with Messrs. Crompton & Co., Limited, was sealed on August 19th, 1892, and by November 28th following, a temporary station had been erected, wherein were installed the necessary plant and machinery, a considerable length of permanent mains had been laid in culverts and casing, and the supply of electric current to the public was commenced, and has continued ever since without interruption. Since that date, the mains have been extended in various directions to meet the public demand, until the total length now laid exceeds 6¼ miles. The erection of the permanent station by the contractors is rapidly approaching completion. The number of houses and buildings connected up to the company's mains is 82, and, including the arc lamps and sockets, the number of lamps attached to the system is equal to 6,169 of 8 candle-power. The applications for the light are steadily increasing, and it is confidently expected that the company will soon be doing a large and remunerative business. From the station report of November 23rd, the net profits of the company, after providing for all administration and other charges, amounted to £18 15s. for the week. It will be observed that on September 30th last the company had issued 3,290 shares, and a few more have since been taken up, but the large amount due to contractors and others makes it a matter of urgent necessity that further capital should be obtained forthwith. The directors have appointed Mr. Robert Payne (chartered accountant) to be the auditor of the company, and it is proposed that he shall submit himself for re-election at the general meeting to be held early next year.

BALANCE-SHEET for September 30th, 1893.

CAPITAL AND LIABILITIES.

	£	s.	d.
Authorised issue, 8,000 shares, £5 each	£40,000	0	0
3,290 shares issued, at £5, £16,450; less arrears, £206	16,244	0	0
Loan from bankers	2,500	0	0
Consumers' deposit account	3	0	0
Due to contractors and others	8,565	3	10
	£27,312	3	10

PROPERTY AND ASSETS.

	£	s.	d.
Electric generating station, mains, plant, machinery, and instruments; cost to date	24,761	16	10
Meters, &c....	583	4	0
Office furniture and fixtures	69	4	11
Sundry debtors for current, meter rents, &c.	301	14	8
Preliminary expenses, including legal and other costs attendant upon the transfer of the Hove Electric Lighting Order and installation suspense account...	908	7	10
Cash at bankers and in office	423	5	7
Profit and loss account balance	264	10	0
	£27,312	3	10

PROFIT AND LOSS ACCOUNT, September 30th, 1893.

	£	s.	d.
To Wages at station and engineer's superintendence ...	308	1	4
„ Fuel, water and stores	130	10	10
„ Rent, rates and insurance	110	6	11
„ Stationery, printing and general expenses	81	17	3
„ Directors' fees and salaries (proportion of)	222	18	7
„ Interest on loans	27	18	11
	£881	13	10

	£	s.	d.
By Current sold, and public lighting	574	13	6
„ Meter rents	42	10	4
„ Balance, net loss to date	264	10	0
	£881	13	10

Commercial Cable Company.—The directors have declared a quarterly dividend of 1¾ per cent., payable on the 2nd prox.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 3rd, 1893, amounted to £902; week ending December 4th, 1892, £907; decrease £5: total receipts for half-year, 1893, £18,221; corresponding period, 1892, £18,043: increase £178.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of November were £3,800; as compared with £3,362 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November, 1893, amounted to £2,442, against £2,157 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in November 1893, were £21,600; January 1st to November 30th, 1893, £248,400; corresponding months, 1892, £245,600; corresponding months, 1891, £260,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 1st after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,429.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, November 29th.	Closing Quotation December 6th.	Business done during week ended December 6th, 1893. Highest.	Lowest.
184,500£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 –103	100 –103	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	43 – 45	43 – 45	44½	43⅜
2,932,680£	Do. do. 6 p. c. Preferred	Stock	82½ – 83½	82 – 83	83½	82⅛
2,932,680£	Do. do. Deferred	Stock	7½ – 8	7½ – 8	7⅝	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¾ – 12¼	11¾ – 12¼	12	...
18,700£	Do. do. 5 p. c. Bonds	100	100 –103	100 –103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 –111	107 –111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝ – 2¼	2⅝ – 2¼	2⅝	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼ – 2⅛	2⅛ – 2⅜	2⅜	2 3/16
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	106 –108	105 –107	107½	106
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4⅜ – 5⅛	4⅜ – 5⅛	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 – 3	2 – 3	...	...
630,000£	City and South London Railway	Stock	28 – 33	28 – 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11⅛ – 11⅜	11⅛ – 11⅜	11⅜	11¼
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅜ – 13¼	12⅜ – 13¼	13⅛	12 5/16
10,000,000$	Commercial Cable, Capital Stock	$100	140 –150	140 –150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16 – 3/16	1/16 – 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4¼ – 4⅜	4 – 4⅛	4¼	...
50,000£	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 –101	96 –101	...	...
16,000	Cuba Telegraph, Limited	10	11½ – 12½	11½ – 12½	12⅛	12
6,000	Do. do. 10 p. c. Preference	10	18 – 19	18 – 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ – 3½	2½ – 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ – 9½	8½ – 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½ – 11⅝	11½ – 11½	11⅝	11⅜
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ – 15	14⅝ – 15⅛	15⅛	14⅝
70,000	Do. 6 p. c. Preference	10	15½ – 16½	15½ – 16½	16⅛	15⅞
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 –111	108 –111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 –117	114 –117	115⅝	114½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15¼ – 15½	15⅝ – 15⅝	15 9/16	15 5/16
62,700£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 –105	102 –105	...	...
222,800£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 –105	102 –105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	114 –117	114 –117	116½	115⅝
108,700£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 –105	102 –105	...	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 –105	102 –105	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 –105	102 –105	...	...
200,000£	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	105 –108 %	105 –108 %	105½	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	... ...	... ...	1 3/16	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 – 1/8	... ...	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	1/8 – 3/16	1/16 – 3/16	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/8 – 3/16	0 – 1/8	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	¼ – 1½	¼ – 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8⅜ – 8⅝	8½ – 8¾	8⅝	8½
150,042	Do. do. 6 p. c. Preference	10	14⅞ – 15½	15⅛ – 15⅜	15¼	15 1/16
150,000	Great Northern Tel. Company of Copenhagen	10	20 – 20½	20 – 20½	...	...
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 –106	103 –106	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ – 5½	4½ – 5½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 – 7	6 – 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ – 22½	21½ – 22½	22	21⅞
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 –104	102 –104	...	...
17,000	Indo-European Telegraph, Limited	25	40 – 43	40 – 43	40½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 – 2	1 – 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½ – 4⅝	4½ – 4⅝	4 7/16	4 3/16
15,000	Do. do. fully paid	5	6⅞ – 7	6⅞ – 6⅞	6⅞	5½
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5½ – 5⅝	5½ – 5½	8½	4⅜
6,295	Do. do. Pref., £6 paid	10	6½ – 6¾	6½ – 6¾	6⅝	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 – 6	4 – 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	105 –108	105 –108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	7¼ – 7⅜	7⅜ – 8¼	7⅜	7½
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	106 –109	103 –106 xd	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1/16 – 1/8	1/16 – 1/8	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 – 3	2 – 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ – 5	4⅜ – 5	4 13/16	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 – 15	14 – 15	14⅝	14 11/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½ – 14½	13½ – 14½	14	...
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ – 5½	5¼ – 5½	5 7/16	...
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 –115	113 –115	...	...
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½ – 5½	4½ – 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16 – 1/16	1/16 – 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	102 –105	102 –105	...	...
11,802	Reuter's Limited	8	5½ – 6½	5½ – 6½	5⅞	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6 – 6½	5⅝ – 6½	6 1/16	5 15/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 – 8½	8 – 8½	8 1/16	...
3,381	Submarine Cables Trust	Cert.	113 –118	113 –118	116½	116
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 – 2½	2 – 2½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	35 – 37	36 – 38	37	36
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	104 –107	104 –107	...	...
58,000	United River Plate Telephone, Limited	5	2 – 2½	2 – 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 – 100	90 –100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ – 6½	5½ – 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	98 –101	98 –101	...	...
30,000	West Coast of America Telegraph, Limited	10	2 – 3	2 – 3	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 –103	99 –103	...	...
€4,242	Western and Brazilian Telegraph, Limited	15	5½ – 6½	5½ – 6½	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½ – 5⅝	5½ – 5⅝	5½	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1 – 1½	1 – 1½	1 7/16	1¼
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 –106	103 –106	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 –106	103 –106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½ – 1⅝	1 – 1¼xd	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 – 10½	9⅝ – 10¼xd	10⅛	9⅝
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 –10	8½ – 9¼xd	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 –111	108 –111	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 –118	113 –118	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	102 –105	102 –105	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 – 5⅛	5 – 5⅛	5 7/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5⅜—6¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 107—109.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investments, shares of £5 (£1 paid), 1½—2½.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1—2.—Do. 7 per cent. Preference of £5, 4½—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4⅝—5¼, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6½—7.—Liverpool Electric Supply, £5 (fully paid) 6⅜—6¾.—Do. £3 10s. paid, 4¼—4⅝.—London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛—Manchester Edison and Swan Company £9 (£1 paid), ¼—½.—Queen Anne's Mansions Lighting and Heating 6 per cent. £100 Debentures, 101—103.

Bank rate of discount, 3 per cent. (October 5th, 1893.)

HOW PROF. KENNEDY PROPOSES TO LIGHT EDINBURGH.

PROF. KENNEDY, in his report to the Town Council of Edinburgh, suggests the following plan:—

"The determination of the best system to be adopted is, of course, the matter which has taken up the greater part of my attention. The question is, in almost all cases, a difficult and complicated one, and Edinburgh has been no exception to this rule. The actual electric light as given out by incandescent lamps is absolutely the same, and equally good, by whatever system generated. There are, or may be, differences between the different systems in capital cost, in cost of production, and in general convenience of application and ease of regulation, but not in quality of light. Bearing these points in mind, I have found it necessary to make detailed estimates of several different schemes for lighting the city by different systems, and my recommendation is the result of a comparison of these. In regard to the two principal points, namely, the double requirement of minimum initial cost, coupled with minimum cost of working, it may of course happen that both these minima cannot be reached by the same system in any given place, and in that case the one has to be balanced against the other. But in addition to these obvious considerations, I have had to bear in mind two other very important ones, namely:—(1) that, if possible, the system used should be such that one central station should serve for the whole of the city for at least a long time to come; and (2) that it should be such that very large extensions can be made as required without going beyond the original lines, and without unreasonable additional cost.

"From this point of view I found it necessary to compare the possible future demand in the South of Edinburgh with that probable in the northern district now to be supplied. I have no doubt that a demand will grow up in the southern district. If this district had been at all likely to yield as large an income as the northern district, it would probably have been worth while to put down a special station for it, in spite of the inevitable drawbacks of having more than one central station. I find, however, from a careful examination of the number of houses and length of streets in it, that it will require about twice the length of mains to supply it that is required by the northern district, and that at the same time it can never be expected to yield much more than a quarter the income of the northern district. The cause of this is, of course, the fact that it is mainly a residential district, and further, that its houses are somewhat widely separated from each other, instead of being built in compact terraces. Under these conditions it becomes specially important that a second station should not have to be built for this district, as such a station would be so much smaller, and so very much less profitable than the northern one. These circumstances have decided me to recommend to you a plan by which both districts should be supplied, as time went on, from the one station."

LOCAL CONDITIONS.

"For a compact urban district like Northern Edinburgh, in which the lighting will be very heavy, there are practically four possible systems, with various modifications. These are:—(1) a three-wire system, something like that which I have used in Glasgow; (2) a five-wire system, such as that which is about to be started in Manchester; (3) some modification of the "Oxford" system; and (4) a combined high and low tension system, such as that used by the City of London Company. I have, after consideration, dismissed the five-wire system and the Oxford system as being unsuitable under the circumstances, and have worked out in detail only the other two. I have proceeded on the assumption that the central station should be situated in Dewar Place, and that it should supply current sufficient to keep 20,000 lamps of 8 candle-power alight at one time, which is probably equivalent to about 40,000 lamps actually installed. This is the figure which I gave in my preliminary report. For this purpose the station should contain (whatever the system used) engines of about 1,500 indicated horse-power (including reserves) with the corresponding dynamos or alternators and boilers, &c. With a three-wire system there would be heavy trunk mains acting as feeders, and delivering current to the distributing network at various points throughout the town at a pressure of about 220 volts, but there would be no machinery or apparatus of any kind beyond the walls of the central station. With the high tension system the current would be delivered from the station at about 2,500 volts, and carried by small high tension feeders into some six or eight transformer sub-stations, placed in cellars or other suitable positions throughout the district. In these sub-stations there would be placed the necessary transformers and other apparatus for redistributing the current by low tension sub-feeders into the network at 220 volts."

COST OF PLANT.

"The total cost of the plant in the central station, and the space taken up by it, I find to be practically the same in both cases. The cost of the distributing mains is also practically the same in both cases. The cost of the low tension feeders also works out the same as the total cost of the combined high and low tension feeders, the transformer sub-stations and the transformers themselves, with their instruments and connections. The total cost in each case, including an allowance of £10,000 for buildings, and including also the arc lighting plant, but not including the cost of land, will be about £80,000, or £5,000 less than the sum stated in my original estimate. The cost of doubling the capacity of the plant and mains, when this should become necessary, would be about £30,000 in the first case, and about £28,000 in the other. There is thus no practical difference in capital cost between the two systems, and so far as expense goes, the decision as to which is best in this case must depend on the cost of working them. The working costs for a three-wire system are well known, as many are in operation. The cost of working a combined high and low tension system can hardly yet be said to be known, as no system of this kind has been at work anywhere for a sufficient length of time. It has, unavoidably, the considerable additional annual expense of the rents of the transformer sub-stations, and the wages of the men employed to attend to them, and including this, the lowest estimate which I can make of the difference in cost of production between the two systems is 0·5d. per unit on 680,000 units per annum; the difference might well be much greater. The balance of advantages, therefore, seems to me very much in favour of the use of a three-wire system for the northern district, and I recommend the adoption of this system.

"In the southern district—for, as I have already said, I consider myself bound to consider this district as well as the other, in order that you may not be saddled with arrangements which shall prove unsuitable in the future, however advantageous for the present—the balance of advantages is altogether altered. The average length of feeders, which, in the northern district, is about three quarters of a mile, would be more than doubled, and the heaviest consumption would be at the ends of the longest feeders. In many places, too, the houses are so far apart, that the cost of low tension distributing mains would be disproportionate to the income likely to be derived from them. These conditions are just those in which the advantages of an alternating current system make themselves felt. Not only is the additional outlay caused by the increased length of feeders much less than with low tension, but it is also possible to supply current to scattered terraces, and isolated houses with transformers in the separate houses, at the same time using special transformers with low tension distributing mains wherever the demand for current justifies this. I think, therefore, that in supplying the southern district, it will be advisable to use an alternating current high tension system (at not less than 2,500 volts), laying down low tension network wherever it may be found worth while to do so."

TWO SYSTEMS.

"The local conditions which I have briefly summarised above, therefore, indicate that a low tension system should be adopted at once for the northern part of the city, and a high tension system for the southern part when it has to be supplied, and for any other isolated or outlying parts, such as the terraces on the Calton Hill. I have already said that I thought the whole city should be supplied from one station, at least until the demand was very much greater than anything at present contemplated.

"There are, of course, certain obvious inconveniences in the use of two systems from one station, but these exist much more in imagination than in reality. The boilers, steam pipes, pumps, and buildings would be the same for all the plant, and there is no reason why the same type of engine, at any rate, should not be used throughout. Practically the double system involves merely the use of electrical machines and switchboards of two different types in the same station, and I see nothing in this which is sufficient to justify me in rejecting, for either district, the plan of supplying it with electrical energy which appears undoubtedly the best for it. I recommend, therefore, that the central station in Dewar Place should be so arranged that extensions for the lighting of the southern half of Edinburgh, when this is required, can be made on an alternating current system such as I have mentioned."

ARC LIGHTING.

"If the station were to be entirely a continuous current station, I should have recommended that series arc lighting machines, of the usual construction, driven by separate engines, should be used for the street lighting, as has been done in Glasgow. As, however, there will in any case no doubt be alternators in the station before long, I recommend that two alternators be put down at once and used for arc lighting by the employment of Mr. Ferranti's constant current commutators. So far as I have seen this apparatus, it seems to be successful for the purpose of supplying a current suitable for the working of arc lamps in series, and its use with alternators will have the enormous economic advantage that special plant will not be required for the arc lighting, which can be worked from the ordinary switchboard used for the alternating currents."

GAS ENGINES.

"When working out the scheme which I have described, I found that it would have been both convenient and economical to use one or more sub-stations containing gas engines driving dynamos. Such stations would entail very little additional expense in the way of attendance, as they would only be worked during the hours of maximum load, and then only during part of the year. They would also have allowed the cost of the mains to be considerably reduced. I regret, however, that the final decision of the Gas Commissioners, of which a copy has been sent to me, appears to render it impossible for any scheme of this kind to be carried out economically."

WORKING COSTS.

"In my preliminary report I stated that the total works cost, including office expenses, should be about 3d. per unit when your output reaches 300,000 units per annum, and 2·5d. per unit when it is 680,000 units per annum. The interest and sinking fund on £100,000, if taken at 5 per cent., amount to 4d. and 1·75d. per unit respectively, making the total costs 7d. and 4·25d. per unit for the two outputs. It cannot be expected that the station should pay its way during its first year of working, but where so large a portion of the cost is a fixed charge it is, of course, of the greatest importance to do everything to secure the largest possible output at the earliest possible time. From this point of view I believe it would be the best and safest policy to start at once with a charge of 6d. per unit, the charge which is now made over nearly the whole of London. In this estimate of output and costs I have, as before, omitted the arc lights entirely, as I presume that the street lighting will be carried out for yourselves at cost price. The rate paid by the Corporation of the City of London is £27 per annum for each arc lamp, including trimming and the supply of carbons—no doubt it might cost you somewhat less.

"(Signed) "ALEX. B. W. KENNEDY."

THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held in their apartments at Burlington House, on Thursday last week. The auditors of the treasurer's accounts having read their report, and the secretary having read the list of Fellows elected and deceased since the last anniversary, the PRESIDENT (Lord Kelvin) delivered the presidential address. He said since their last anniversary meeting, the Royal Society had lost 11 fellows on the home list, and two foreign members. The ages of the home members ranged from 58 to 89 (Sir R. Owen), and seven were over 80 years of age. The generous gift of £2,000 by Mr. Ludwig Mond, early in the session, to aid the work of the "Catalogue of Scientific Papers," had enabled the catalogue committee not only to carry on the current work of the catalogue, which want of funds threatened to cripple, but also to take into consideration wider schemes than it was possible to contemplate before. The committee had met several times during the past session, and it was hoped that the long desired Subject Index might yet become an accomplished fact. In the mathematical and physical section of the *Philosophical Transactions*, 21 papers had been published, and in the biological section, 10; the two sections together containing a total of 1,775 pages of letterpress, and 70 plates. Of the *Proceedings*, 12 numbers had been issued, containing 1,282 pages and 19 plates. Not the least important of the scientific events of the year was the publication, in the original German, and in an English translation by Prof. D. E. Jones, of a collection of Hertz's papers describing the researches by which he was led up to the experimental demonstration of magnetic waves. Fully to appreciate the book now given to the world, they must carry their minds back to the early days of the Royal Society, when Newton's ideas regarding the forces which he saw to be implied in Kepler's laws of the motions of the planets and of the moon were frequent subjects of discussion. In 1684 the Senior Secretary of the Royal Society, Dr. Halley, went to Cambridge to consult Mr. Newton on the subject of the production of the elliptic motion of the planets by a central force. Some time later, Halley was requested to "remind Mr. Newton of his promise to enter an account of his discoveries in the register of the Society," with the result that the great work "Philosophiæ Naturalis Principia Mathematica" was dedicated to the Royal Society, was actually presented in manuscript, and was communicated at an ordinary meeting of the Society, on April 28th, 1686, by Dr. Vincent. On May 19th following, the Society resolved to print the work, but the publication of Willoughby's book, "De Historia Piscium," had exhausted the Society's finances to such an extent that the salaries even of its officers were in arrears. Accordingly, at the council meeting of June 2nd, it was ordered that "Mr. Newton's book be printed, and that Mr. Halley undertake the business of looking after it, and printing it at its own charge, which he engaged to do." Those who knew how much worse than law's delays were the troubles, cares, and labour involved in bringing through the press a book on any scientific subject at the present day would admire Halley's success in getting the "Principia" published within about a year after the task was committed to him by the Royal Society 200 years ago. It was by sheer perseverance in philosophical experimenting that Hertz was led to discover a finite velocity of propagation of electro-magnetic action, and then to pass on to electro-magnetic waves in air and their reflection. During the 56 years which had passed since Faraday first offended physical mathematics with his curved lines of force, many workers and many thinkers had helped to build up the Nineteenth Century school of *plenum*; one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, would be a permanent monument of the splendid consummation now realised. But, splendid as this consummation was, they must not fold their hands and think or say there were no more worlds to conquer for electrical science. The Royal Society's *Transactions* and *Proceedings* of the last 40 years contained almost a complete history of the new province of electrical science which had grown up, largely in virtue of the great modern improvements in practical methods for exhausting air from glass vessels, by which we now had vacuum tubes and bulbs containing less than $\frac{1}{1000000}$th of the air which would be left in them by all that could be done in the way of exhausting by the best air-pump of 50 years ago. Varley's short paper of 1871, which, strange to say, lay almost or quite unperceived in the *Proceedings* during the 22 years since its publication, contained an admirable first instalment of discovery in a new field—the molecular torrent from the negative pole, the control of its course by a magnet, its pressure against either end of a pivoted vane of mica, according as it was directed by a magnet to one end or the other, and the shadow produced by its interception by a mica screen. Quite independently of Varley, and not knowing what he had done, Crookes was led to the same primary discovery. In the whole train of Crookes's investigations on the radiometer, the viscosity of gases at high exhaustions, and the electric phenomena of high vacua, ether seemed to have nothing to do except the humble function of showing to our eyes something of what the atoms and molecules were doing. If a first step towards understanding the relations between ether and ponderable matter was to be made, it seemed to him that the most hopeful foundation for it was knowledge derived from experiment on electricity in high vacuum; and if, as he believed was true, there was good reason for hoping to see this step made, they owed a debt of gratitude to the able and persevering workers of the last 40 years who had given them the knowledge they had; and they might hope for more and more from some of themselves and from others encouraged by the fruitfulness of their labours to persevere in the work.

The medals were presented as follows:—The Copley medal to Sir G. Gabriel Stokes, for his researches and discoveries in physical science; a Royal medal to Prof. A. Schuster, for his spectroscopic enquiries, and his researches on disruptive discharge through gases and on terrestrial magnetism; a Royal medal to Prof. H. Marshall Ward, for his researches into the life history of fungi and schizomycetes; and the Davy medal to Prof. J. H. van't Hoff and Dr. J. A. Le Bel, in recognition of their introduction of the theory of asymmetric carbon, and its use in explaining the constitution of optically active carbon compounds.

The Society proceeded to elect the officers and Council for the ensuing year. The following is a list of those elected:—President, Lord Kelvin; treasurer, Sir John Evans; secretaries, Prof. Michael Foster, Lord Rayleigh; foreign secretary, Sir Joseph Lister; other members of the Council, Prof. I. B. Balfour, Dr. A. A. Common, Dr. A. R. Forsyth, Mr. R. T. Glazebrook, Prof. A. H. Green, Sir John Kirk, Prof. O. J. Lodge, Sir John Lubbock, Mr. W. D. Niven, Dr. W. H. Perkin, the Marquis of Salisbury, Prof. J. S. Burdon Sanderson, Mr. Adam Sedgwick, Prof. T. E. Thorpe, Prof. W. A. Tilden, Prof. W. C. Unwin.

In the evening the anniversary dinner was held at the Hôtel Métropole, Lord Kelvin, the President, in the chair.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

(*Continued from page* 588.)

Mr. W. M. MORDEY expressed his strong sense of the responsibility that was on all speakers in that discussion. He agreed with Prof. Forbes's general scheme, so far as it was an alternate current scheme. He thought all had now come to the conclusion that no large power distribution scheme could be successfully accomplished over long distances, except by the use of alternating currents. But whilst he agreed with the general scheme so far, he did not think the evidence put forward to justify the changes from established practice was quite sufficient to satisfy all of them. Prof. Forbes stated in the paper that "it is a matter of common knowledge that parallel working is assisted by lowering the frequency." With all respect he (Mr. Mordey) could not agree with that. If there was no difficulty whatever in working at 100 periods, there could be no difficulty in working at a lower rate. It might be that with certain types of machines there were advantages in working at lower rates, but he thought that a machine that was incapable of working at 100 periods would work worse at 16 or 40 periods than a machine that would work at 100 periods successfully. The principal support that Prof. Forbes relied on was that of Messrs. Ganz, who had written him "that their reason in adopting the frequency of 42 periods per second was that it is the lowest frequency that is available with arc lights, so as not to produce any serious flickering, and their desire was to lower the frequency as far as practicable in order to ensure parallel working." Now, Messrs. Ganz were very important people; they had considerable experience all over the Continent, but it was very necessary to examine and sift statements of this sort. He thought they ought to ask if there had not been a little forgetfulness in making such a statement as that. In his paper on alternate current working, in 1889, he made a similar statement; he quoted a letter by Mr. Zipernowski to the *Electrician*, in May, 1889, stating that their low periodicity was chosen on principle—"that we by this means are enabled to couple our dynamos in parallel is not a secondary result, but just the end we are aiming at." His (Mr. Mordey's) surprise was very great when, during the discussion, Mr. Zipernowski wrote: "We state that we have not reduced the periodicity because of the coupling in parallel," and adding that they had kept to 42 periods with only slight variations. He happened to know that this last statement was the true one. For years before parallel working was thought of Messrs. Ganz had been making alternators of 42 periods per second; when parallel working was recognised to be a necessity, they made experiments and found they would have to work in parallel; they adhered to 42 periods, and apparently gave out that they adopted it because it gave the best results in parallel working. I am not aware of any other support than that of Messrs. Ganz to Prof. Forbes's statement, and these words taken from Mr. Zipernowski's own writing showed that his last published statement contradicted his first, and acknowledged that they had made these machines for low periods long before parallel working was thought of. The question of artificial loading in putting machines on to mains in parallel had also been dealt with by Prof. Forbes, and had been approved very strongly by Dr. Fleming. Now that was an old, primitive, obsolete method used with the early Edison machines—Jumbo machines, as they were called. An artificial load, consisting of a bank of lamps, was put on to the machine until it was brought up to what it was supposed to do, and then put on to the mains in the way described by Prof. Forbes. But even with the Jumbo-Edison machines it was an utterly unnecessary proceeding. A plan was got out some years ago by Mr. Raworth and himself of regulating the load by the steam by bringing the machine in light with only enough excitation and only enough steam to drive it at no load, connecting it when nothing could go out or come in, and then raising the steam so that they got their load on gradually. Then in taking load off they slowly reduced the steam and they then got the machine off the main with no spark at all. In that way there was no shock whatever, and it was the simple straightforward way that gave no trouble. He thought, even with machines that had a very big drop in the curve, this method of artificial loading was of no advantage, but an active source of danger and trouble. The reason it was used on the Continent was that they were mostly Ganz plants there, and it had become a stereotyped method, and was put in as a matter of form. There was another question affecting the periodicity

to which Prof. Forbes referred as probably the most important. He said: "I am not sure that it ought not to be said that the greatest advantage of low frequency is in connection with the conductors used for transmission, and in the parts of the apparatus that require high insulation." Then he referred to what was strongly pointed out by Lord Kelvin, but which was found out independently by those wonderful experiments of Prof. Hughes's—the surface effects in conductors at high frequency, the tendency of the current to seek the outside of conductors. That was, no doubt, in low tension alternate current distribution, an extremely important matter. He (Mr. Mordey), remembered one case in which it was found impossible to work a 100-volt alternator in an old installation, although the mains and everything else were all right; they actually could not get more than some 75 volts in the lamps, 100 feet, or perhaps as many yards, away. It was some years before he had touched an alternating current, but he felt sure it was an alternate current effect, and if they tried a direct current on it the difficulty would disappear, as in fact it did. But in these high pressures for long distance transmission he did not think those Hughes effects, as he would call them, were by any means serious, even for the large powers Prof. Forbes proposed. In 1889 he gave, in the paper he had already referred to, a table of the virtual resistances of conductors. He could claim no credit for that table; he merely tabulated the results Lord Kelvin had given. This table showed the Hughes effect in conductors at rates of 80, 100, and 133 periods per second. The table showed the limitations imposed by this effect. In the Niagara scheme at 20,000 volts the full current on one section of the machine, with two million watts, was only 100 ampères. Prof. Forbes selected 350 ampéres to the square inch as a suitable density; he thought a larger density would be more economical unless their power was going to be very costly. But taking that density from his table of Lord Kelvin's results he found that at 100 periods per second, or six times as high as Prof. Forbes intended to use his conductor, there was scarcely any Hughes effect at all—there was only 5 per cent. or 6 per cent. increase over the ordinary loss—while at 133 periods, which was common in the States, the Hughes effect was scarcely perceptible. Prof. Forbes allowed a loss of 3·5 per cent. by the Hughes effect; that would only be increased to 3·7 per cent. Was it worth while going down 33 periods per second in order to gain ·2 per cent. in distribution over the same copper for 20 miles? He said, certainly not. Even for the 2,000-volt transmission the limit of solid conductor one could use was about $\frac{3}{4}$ inch in diameter. There were many practical reasons why one should not use a solid conductor, or even a stranded conductor, much larger. One could put up a flat conductor, a wide strip, so that even for the 2,000-volt transmission the Hughes effect would hardly tell. It would not be anything like as serious as what he imagined it was the intention to use in that tunnel, the 20,000-volt mains, one on each side of the machine. If those were made concentric, or the mains put close together, there would be a far greater gain than the loss from the other cause. It was of far more importance to have those leads close together than to get rid of the Hughes effect, because there was not any Hughes effect to get rid of, not even at 100 periods. Then, still keeping to the question of low periodicity, they came to the question of transformers. He would like to read a paper on that subject; but if he might be allowed two or three minutes, he would just say briefly how it presented itself to him. Prof. Forbes said that at a low periodicity the output was nearly double if the frequency was quadrupled, the hysteresis being kept constant. He supposed that the $c^2 n$ losses would also be kept constant, at any rate they would not be less, but actually greater, as they went down in the periods. It was impossible by any amount of money, or space, or time or thought, to make a transformer anything like as good at a low period as at a high. It was not a question of design or of money. The ordinary idea that they could design a transformer to be equally good under any given set of conditions, so far as periodicity was concerned, was an entire mistake: it was not possible. If they took a transformer made for 16 periods or 40 periods, and ran it at a higher periodicity, it would give a very much better effect. They could design a transformer to give the best possible effect with a given period; if they increased or decreased it in size the efficiency went down. Prof. Forbes said that by using this low periodicity he had a gain of 3 per cent. more power at his disposal in the motors at the other end, and that the transformer only cost about 50 per cent. more. But what did that mean? The author said a transformer would give 132 units instead of 100 if they doubled the frequency, and if the frequency were quadrupled they would get 174 instead of 100, or nearly only double the output: the hysteresis and $c^2 n$ losses remained the same, therefore the proportion of the losses had doubled. He had a triple transformation, first up from his dynamo to his mains, then from his mains down to the 2,000-volt transformers, and then down to 100 volts, probably, for his motors, for they were going to be worked at low voltages and with transformers. Therefore there was a triple transformation, and, probably, a sixfold loss. What did he gain? A motor that had 3 per cent. more efficiency than if he used a high periodicity one. Those extra losses in the transformers covered what gain he thought he would get in the motors. He would not get the gain in the motors, as a matter of fact, but, even if he did, those losses would cover it. He approved the transforming up from the generator. That was very much better than attempting to generate from 20,000 volts, but he did not see why they should transform up from 2,000 volts to 20,000; 2,000 was not so safe as 500 volts, and it was just as easy and cheap to transform from 500 to 20,000, as from 2,000 to 20,000. He would pass over what he had intended to say about the commutation of current, but he would say this: Prof. Forbes had cut himself off from the possibility of using a commutated current by this low periodicity, because it would have flickered in it. He had cut himself off from using current directly in any way, except for power; he must always transform to a higher periodicity or to a direct current, if he was going to use his power for lighting. For instance, it would be far better and cheaper in the Buffalo case to put commutators in to run the arc lamps direct, and ordinary transformers for private lighting service, but he could not do that. A point of very great interest to people considering multiphase working was the bad regulation of the machines when the load was varied, and Prof. Forbes had said a good deal about it. He (Mr. Mordey) once tested what Prof. Forbes said was the first multiphase machine, an old Gramme machine used for the Jablochkoff lights. If they took off on the one side, the volts on the other went up enormously. That was one of the difficulties experienced in the modern multiphase machinery. He believed it was a question of design; if they designed a machine with a reasonably straight characteristic, they would not have this bad effect. Ordinary dynamos that had a curve that went down like the Falls of Niagara, were unsuited for this kind of working. As to the capacity effect, he was afraid the capacity for holding a charge of dirt was the most important of all, and caused far more break-downs than anything else.

The PRESIDENT said there was one point on which he thought, like himself, most of the members would wish to hear one word more from Mr. Mordey. He had commenced by saying that he had had experience of an alternator in London, which owing to the Hughes effect dropped its potential down to 75 volts, and afterwards he said he did not think a frequency of 100 would produce any effect at all. Did he know the frequency of the particular alternator to which he had referred?

Mr. MORDEY thought the machine ran at something like 200 periods a second. He could find out, and put in a foot note to his remarks in the *Journal* if it was thought to be of any interest.

The PRESIDENT: Do you not think the effect was due to the external field, an iron pipe, or something of that sort?

Mr. MORDEY: There was no iron pipe or lead sheath or anything of that sort. They were plain copper wires run a few feet apart in the roof of a long building, in an exhibition, as a matter of fact. The most distant light was not more than 120 yards away; the current was large, and the effect was partly a Hughes effect and partly, he now believed, an impedance effect.

The PRESIDENT: In the mains or outside the mains?

Mr. MORDEY: Oh, in the mains.

Mr. GISBERT KAPP said he thought the Institution ought to feel proud of the fact that one of its members had been selected for this most important work. He was quite sure they all felt it was a honour to themselves that their colleague was the scientific adviser to the Cataract Construction Company. He made this preface to his remarks in order that Prof. Forbes might not think his judgment was biased; if he were biased at all it was in Prof. Forbes's favour. There was one point which struck him on reading the paper for the first time, where the author was discussing the merits of the number of phases, whether they should have a single phase, or two or three phases. When he (Mr. Kapp) was in America in the summer he had a long talk with Prof. Thompson upon this subject, who tried to convince him that three phases would require less copper than two. He then read all that Dobrowolski and others had written on the subject, and the result of his investigations was this: if they compared different systems of transmission they must have a basis of comparison. The basis of comparison he took was the practical basis of putting it as a primary condition that all the systems compared should have the same safety as regards insulation, or, to put it in other words, that the stress on the insulation should be the same in all cases. Now, if they took the continuous current as the most economical basis on which they could work, it was quite evident that the alternating current required more copper because the effective pressure must be lower to give the same stress at the crest of the E.M.F. wave. Suppose they found the copper in the line weighed 100 tons, if the transmission was by continuous current. If they now worked a different line with the same length, and the same efficiency of transmission, and the same stress on the insulators with an alternating current, they would double the copper, which would now weigh 200 tons. If they used two phases with four wires they would again require 200 tons; but if they thought to save copper by using only three wires and working two phases they would require 290 tons, so that the system which Prof. Forbes recommended as the most economical in copper was actually the worst. If they had three wires and worked at three phases they would use 150 tons only. Two-phase working with three wires was out of the competition altogether, it was too expensive. Prof. Forbes gave a calculation (but did not show how he arrived at it), in which he stated that if you assumed the Steinmetz law that the hysteresis loss was proportional to the induction raised to the power 1·6, the output of the transformer varied as the frequency raised to the power 0·4. He (Mr. Kapp) could not make 0·4, but 0·375. He mentioned this because it was rather in favour of Prof. Forbes's contention that the cost of the low frequency transformer was not much greater than that of the high frequency transformer; but he quite agreed with Mr. Mordey that no amount of money or iron would make it so efficient. Therefore, the low frequency must have proportionally greater loss until somebody invented perfect iron. As regards the motors, he had again the misfortune to differ from Prof. Forbes. The latter thought that the low frequency motor would be more efficient, and at the end of his paper a calculation was given to show that the losses in the high frequency motor were 42 per cent. greater than in the low frequency motor. He quite agreed with the 42 per cent., but he was afraid Prof. Forbes had overlooked the fact that with the high frequency they would have to supply $2\frac{1}{2}$ times the E.M.F., and it would give $2\frac{1}{2}$ times the power, and, consequently, what appeared to be an increase in the loss of 42 per cent. became actually a gain of 33 per cent., so that on his own showing the high frequency motor was the more efficient. One reason which Prof. Forbes had given for the use of low frequency, was that you could make

a synchronising motor out of any dynamo. If they wanted to rig up a motor quickly they could go and buy a dynamo and set it to work. But when he began to consider what had to be done he saw that it was not so simple. They had to put on two contact rings to begin with. Dynamos were cut very fine nowadays; makers did not give extra room for fancy fittings. Therefore they had to send it out to be fitted with these things by a maker. Supposing they had done this, how were they going to start it? Being a single-phase motor it would not start by itself, and they must put down a little Tesla motor, or some other, to start it. And if they did that they might as well use the Tesla motor a little larger and run their factory from it. He would like to point out that single and multiphase alternate current motors were on the market and were very good. The only reason that the impression prevailed in England that they were not to be had, that they were not reliable, and only experimental, was that they were going too credulously by what appeared in the electrical papers. He was afraid the papers were treating them rather badly in this respect. It was the fashion amongst them to cry down multiphase and alternate current work. He could quite sympathise with the editors: it was an unfortunate thing that they had to take up new subjects and study them in order to write intelligently about them. But they should not cry down these things; let them, at least, state what the facts were. He had tested a single-phase motor made by the Œrlikon Company, with the following results: the machine gave on the brake 862 watts, and it ran at a speed of 1,800. The frequency varied from 60 to 67; the commercial efficiency was 60 per cent.; the power factor was 74 per cent; and at starting the current to produce a torque equal to the full output of 1½ H.P. was 2½ times the normal working current. It was rather inconvenient to have such a large current at starting, but by a very ingenious arrangement, now used all over the continent, the mains did not feel this large current. There was an auto-transformer with a switch handle which transformed the higher pressure of the mains into lower pressure at which an increased current went into the motor, and it worked beautifully. The weight of that machine was under 1 cwt. per H.P. He might say that the motor he tested was a thoroughly practical and well made machine, and large numbers of such machines were now being supplied by the Œrlikon Company. There seemed to him to be very strong reasons against the adoption of low frequencies as regards motors, and, perhaps, not so great, but still sufficient reasons as regards the transformers; one further and very strong reason was the cost of the alternator. He had studied the design of Prof. Forbes's alternator very carefully, and he might say at once that he was very pleased to be able to agree with him that it was about the best machine that could be made for the job. It was most beautifully designed. He had not thought they could get so much out of it until he began to design it himself. He did not know Prof. Forbes's dimensions, but hit upon 10 feet as the smallest size the armature should have, and Prof. Forbes told him that his was 10 feet. He had designed that machine right through, and had put the results in a table. If they had low frequency it meant they had few poles, few armature coils, and, if the coils were to give them high E M F., each coil must have many turns, and if the coil had many turns there must be many ampère turns; and the result would be that a machine which had an armature with many turns would have the nasty habit of wiping out its own field. To prevent that they must give so much field to begin with that they could do with fewer turns at the armature. The result was that high frequency machines were much more efficient than low frequency machines up to a certain point, where constructive difficulties came in. He had taken the Forbes machine and worked it right through, and the final result was that in the 16-frequency machine the active material—by which he meant the armature iron and the field iron—weighed 95,000 lbs. They might take it that with the low frequency machine they got one electrical horse-power for every 19 lbs. of active material No alternator so light for the output had ever before been designed. But if they doubled the frequency it was still more excellent, for they could do one electrical horse-power with 11·8 lbs. of active material.

Prof. SILVANUS THOMPSON thought there was no need to apologise for not employing continuous current for such a purpose as this, when they could do so much more with an alternating current. But to have so many opportunities of changing it round, transforming it in one way or another as the occasion might require, pointed the scheme out as a wonderful illustration of the various ways which might be employed in order to handle the energy placed at their disposal and applying it for various specific ends. The paper bristled with points, but he would confine his remarks to one or two. In the first place some rules concerning parallel working were given, or rather some remarks were made about the knowledge or want of knowledge upon that which constituted the successful design of machines for working in parallel. Prof. Forbes said: "The rules which govern the construction of machines which shall work well in parallel are not very clearly understood. The only fact which has been perfectly established in practice is that the lower the frequency the more efficient and sure is the parallel working." He, too, felt disposed to dispute that point. He need not dwell upon it—he simply disputed it; it had not yet been established; it might be true, but it had not been established. But he did venture to think that this was not the only fact bearing upon the question of the construction or the design of machines for parallel running. In the first place they knew perfectly well that machines would not run well in parallel if they had weak field magnets, if they had armatures that the output that the machine was designed for would perturb or interfere with the magnetism of the field in any serious way. Further, they knew that they did not get easy working between two alternators of distinctly different types. In this case if the two alternators were so designed, whether in the placing of their coils, or the shape of their pole pieces, or the relative positions of coil and pole pieces, the curves of their induction were widely different, one giving a form nearly like a sine curve and the other giving a curve like a saw-tooth curve, they would run in parallel. If the curves were different under any conditions, could they avoid having a very considerable idle current passing continually to and fro between the machines? These were points that really were known and bore largely on the question of design. Further, he would like to point out that they sometimes spoke of the self-induction in the armature and of the magnetising or domestic reaction of the armature as though they were the same sort of thing, and though they were in one sense the same sort of thing, they must be carefully distinguished from one another. There was no doubt whatver that an armature which had no iron in it or in close proximity to it would have less self-induction and armature reaction than an armature that had much iron in it and that iron in close proximity to the coils. But they might have an armature which had much self-induction without necessarily very much armature reaction. It depended upon how the iron was disposed near the armature coils with respect to the approach to the polar parts, and the thing which was disastrous in the design of an alternator for these purposes was in the putting of self-induction into the armature, the putting of iron into the armature in such a way that the iron acted violently on the magnet and pulled it about so that the field became an unsteady one. In a paper read about six years ago by Mr. Kapp, attention was drawn to the armature reaction and to the way in which one might describe it graphically by drawing load curves for a dynamo. He thought the matter then referred to was continuous current machines, but Mr. Kapp gave them a curve of excitation of a machine when no current was going through the armature, and when a current of given strength was going through, and they could compare the curves side by side. Similar load curves could be drawn out for alternators, and it was quite certain that any alternator which, with a large load through the armature, required very much more excitation of the field magnets than it did on open circuit would be one that might be difficult to regulate from this point of view. All this, of course, was contained in those wonderful equations on the action of alternate current machines which Dr. Hopkinson published about 1884. He (Prof. Thompson) was perfectly well aware that the whole theory of alternate working and parallel running could be dug up from those equations or the integral solution of them. But it was more to the point if they enquired what was the physical action which went on and made it easy or difficult for two machines to run in parallel when they were placed on the same circuit, and the physical effect was really easy to follow out. Take, for example, one of the ordinary types of alternator, say, for example, the Westinghouse, and suppose the core to be rotating right-endedly and the wires to be on the outside, the tendency would be to generate currents which would come toward you as the wire was passing the S pole, and to go away from you as the wire was passing the N pole. That was to say, the E.M.Fs., everything being supposed to be symmetrical, would be at their maxima as those coils died away to nothing exactly half way between. Suppose they had two such machines, exactly alike in phase with one another. Their E.M.Fs. were at a maximum at that particular instant, and if there was no lag in the current, no self-induction, they would have the currents also at a maximum at that particular point. Now, suppose they had those two machines coupled together in parallel, the E.M.Fs. were equal if other things were equal, and there was no tendency for one machine to send a current through the other one either way. Now, suppose one was a little behind and the other a little ahead, then the E.M.Fs. would not necessarily be equal. The consequence would be that they would have as a load thrown on the leading machine tending to bring it back, and a load tending to bring up the lagging machine, and they tried to get into phase with one another. But now suppose that the current was capable, by reason of the disposition of the iron or anything else, of producing considerable reaction, then it would strengthen the field in front of it and weaken it behind. As a matter of fact the question of strengthening the field in front of it or weakening the field behind it, strengthening the field, as a whole, depended upon whether the strengthening or weakening was a maximum when the coil was in the alternator or not. If the maximum was reached when the wire was behind the middle position, it considerably strengthened the field, but, if the maximum occurred when the wire was behind the middle position, it would weaken the field. The one that was ahead of the other would weaken its field, while the other one would strengthen its field. These two reactions, the one of strengthening, the other of weakening, precisely tended to defeat the tendency of the two machines to get back into parallel; that was to say, the back armature reaction would of itself tend to prevent the synchronism to parallel. He need hardly point out further that it was not quite fair to those who had worked on both sides of the Atlantic on this question of the synchronism of machines, for Prof. Forbes to throw at their heads the experience gained by Ganz with one type of machine under one set of conditions. One other question, and it was largely one of the engine and the mode of governing, even with the best types of machines, he thought if a spaced field had the least armature reaction, they might have difficulties if the power was governed unsuitably. He wished they could have heard Dr. Fleming on that point, for he was well acquainted with the installations at Rome and Tivoli, and had views and experience. He (Dr. Thompson) wished to be distinctly understood that in pointing out that great armature reaction was deleterious to the easy synchronising of machines in parallel, he thought self-induction in the armature was not necessary; that was to say if they could support the two facts, if self-induction could be put into the armature in any other way without having the magnetic operation of self-induction splitting itself in the field magnet, and so distorting the magnetism of the field, then it would not be the disadvantage that it was when it existed in this form of action which was both a self-induction and a reaction against the magnetism of the field. In fact, he could see that under certain circumstances self-induction in the armature must be an advantage rather than otherwise. He wished to return to some remarks made about the difficulties of working stations from the sudden rush of

current when the machine was thrown in or thrown out. All station working tended to simplify itself, and he thought in all stations switches were provided for breaking the enormous currents—switches to carry large currents without burning up the points of contact. All engineers had fallen into the way of breaking under conditions in which they could bring the current down to a small amount before the switch was opened, and, conversely, they brought those conditions about before the switch was closed, which would not have a large current about when the switch was closed. They did not operate by making or breaking large current suddenly. With regard to alternating motors, it ought to be pointed out that efficiency in proportion to output was not quite to be accepted without reservation. It might be perfectly true for motors of a certain type; but the question of whether a motor was more efficient with high or low frequency, depended surely on the design of that motor, where the losses came in in that motor. If there was large resistance in the internal parts there was great loss by heating, whereas, if the loss was made up not of heating mainly, but of eddy current and hysteresis, the operation at a low periodicity might be of advantage. But the argument had been quite irrespective of the design of the motor, that it would be more efficient at a low periodicity, and he did not think it was true. Lastly, he wanted to congratulate Prof. Forbes upon introducing the useful Americanism, "power house," instead of central station.

Mr. J. SWINBURNE said the first thing that struck him on reading the paper was not a purely electrical question but a commercial one, and that was, what was this power going to cost? what was it going to be sold at, who wanted it, and what were they going to do with it? The cost of the power was not given in the paper. In time it must become public property, and he could not be asking Prof. Forbes any secret, because villages and cities were being built and factories started, and he hardly imagined the 'cute Yankee was ready to build villages and start factories without knowing what the power was going to cost. This was rather a curious question, and a rather surprising one when they went into it. In most industries the power used was quite a small proportion of the cost of running a factory, whatever it might be. In others of course it was a very large proportion. But in such cases, for instance, as flour milling, the cost of power was really a very small proportion, and it would hardly pay to remove a flour mill to a place where power could be had cheap, from a place where labour was cheap. In other cases, such as tearing up wood pulp, of course, the cost of power was a much more serious matter. But in dealing with very large power plants it generally came out, unless the load factor was very great indeed, that the cost of coal was not such a serious item as they might expect. Some time ago he worked out a scheme for transmitting power from the Midlands to London. It was rather what the Americans called a "wild cat" scheme, inasmuch as there was little probability of its being carried out soon, but he went into it very thoroughly as a matter of interest. And he found it was very largely a matter of interest, for he found the interest and depreciation was so enormous when compared with the cost of coal, that the cost of coal was hardly a factor to be considered at all. There was also another important question in connection with this. They wanted to know who was going to use the power. The problem was entirely different according to whether they wanted to supply small users who required $\frac{1}{10}$th of a H.P. to ventilate, say, an eating house and keep the flies off the customers, or to run printing machines in a district like Fetter Lane, with 2 or 3 H.P., or to drive aluminium works, where they would want hundreds of thousands of H.P. The difficulty with medium powers was to start the motors. That did not come in with large powers; it was a small detail then. A great deal depended on the class of consumers who were going to use these motors. Coming to the question of double or triple currents, or phases as Prof. Forbes called them. He believed Prof. Forbes was an astronomer, and he was rather astonished, therefore, at his use of the term phase. In the undulatory theory of light the term was taken from the case of the planets, but he did not think Prof. Forbes would say that a planet had a three-phase satellite, but three satellites; but that was a very small matter. Referring to the extra output from a double current machine, there was something in that undoubtedly, and as a matter of interest he would like to mention that the question of the transmission of power for long distances by means of double alternating current was really before electrical engineers as early as 1887. He had nothing to do with it himself, so he had all the more pleasure in mentioning that at Messrs. Crompton's they had an enquiry for a large power transmission in Australia, and they discussed a method and decided that it should be alternating. Mr. R. B. Rogers, then his (Mr. Swinburne's) assistant, suggested that the right way to do it was by double current, winding the armature all over with wire. In fairness to Mr. Tesla and others he must say that he did not think Mr. Rogers realised that this double current plant would be self-starting, but he quite realised the other advantages. But the extra output, which was one of the features mentioned by Mr. Rogers, was a little illusory when they dealt with very large machines, as when dealing with machines with large pole-pieces, the induction became concentrated on one side. In large machines the advantage of using double currents for output was not great; he was not sure that it existed at all. The next thing he ought to remark was the very high infrequency which Prof. Forbes used, an infrequency of 0·04 second per period. He would like to add to what Mr. Mordey and others had said about transformers. Everybody who had done much practical designing of transformers would wish to protest against the large amount of general statement in the paper, "all other things being equal," and so on. The whole gist of the matter was in the "all other things being equal." In making a radical alteration such as that, the whole comparison turned on the other things. For instance, in a transformer they might get the loss in iron constant or the loss in copper constant; or they might take the price constant—they could not get any straight up and down comparison. He protested also against the introduction into a scientific paper of "well-known facts." Whenever an author said a thing was a well-known fact, he was sure to be wrong. As to the flickering of lights, one rather important point ought to be threshed out. Helmholtz was the first, he believed, to investigate on the frequency which worried the eye; or whether he quoted or investigated he was not sure. Helmholtz was concerned with the frequency that worried the ear, and went on from that to the frequency that worried the eye, which he found to be a frequency of 25. It must be borne in mind that the frequency of the flickering in the lamp was always double the frequency of the current, so that would mean, according to Helmholtz, that the eye would stand a frequency of 12½. It was very curious that Helmholtz's and Forbes's results did not agree. Prof. Forbes observed a flickering at a frequency of 48, or a frequency in the lamp of 96, whereas Helmholtz said the point of limit was 25, so that there was a very large discrepancy between the observations of electrical engineers and the observations of Helmholtz. As to capacity, he had worked a great deal with condensers. Capacity had two effects, the first what was called the Deptford effect. According to Prof. Forbes that did not come in so much if you reduced the frequency. But then, again, they came to the question, how were they going to reduce the frequency? If they took a dynamo with double the number of turns on each coil and double the breadth of the field magnets, they would find that the capacity effect would be the same. Prof. Forbes took a great deal of trouble to eliminate capacity from his system. He could not help thinking he was wrong there. As soon as he had in all those triple and double current motors he would find he had a whole lot of consuming devices on his circuit wanting lagging currents. Capacity in the mains was very much like putting a redressed circuit round the field magnets. If your machine was fairly highly magnetised it would not go up very much; if the machine was only working at one-fourth of its E.M.F., as at Deptford, when first observed, it might rise considerably. Prof. Forbes seemed to think that dynamo makers put on enormous insulation because of some extraordinary effect that happened in a dynamo. He should never dream of designing a dynamo in that way. If they were working in a parallel system, as they were at Niagara, they disconnected a dynamo from the cables, but they never disconnected cables from the living dynamo. They would always have one dynamo running, and when they shut down they would shut down the dynamo and not disconnect it. He thought they ought to realise that it was not a question entirely of dynamos, but of everything else that came in. They wanted to know whether the turbines were governed individually or the whole lot governed in parallel. He did not think they could say this type of dynamo was bad or that type was good. Mr. Crompton and he went into the question of frequency some years ago, and they advocated about the same frequency as Prof. Forbes, about 20. But on looking into the matter they found they were wrong. In the first place, the transformers came out outrageous. In the second place, a point which Prof. Forbes had not mentioned, there was the heating of the field magnets. If they were going to use very low frequency their pole-pieces would be very broad, the peripheral angle covered being large, and if the pole-pieces were not laminated they would get very hot. If they were laminated in the direction of rotation, they got over the difficulty of heating due to the Foucault currents in it, but they did not get over the difficulty of the enormous hysteresis loss, and he was not sure that this was not going to be an enormous difficulty.

Mr. S. F. WALKER said with reference to the winking of incandescent lamps, if they used thick filaments they could make the frequency as little as they pleased. They got no winking, for instance, with a 200 C.P. lamp. When they got a thick filament a small increase of current, giving rise to a small increase of temperature, was not appreciable, whereas, with a thin filament the increase was immediately apparent. He would like to know what the cost of the culvert which Prof. Forbes described was going to be. It appeared to him that town distribution would have to come to that. At present they buried their cables, and they could not be certain what was going to happen to them. Sooner or later faults would be generated; experience in connection with telegraph lines would bear that out. Therefore, he felt confident that sooner or later subways would have to be made for town work, and the conductors would have to be carried so that a man could walk upright and examine them. Of course, the subways might be used for a good many other things. The only question was one of cost, and it was important to know what that would be. The revolving parts in Prof. Forbes's dynamos were very heavy, and the speed seemed to him to be high. He had followed the designs for the bearings and so on very carefully. They could provide for the speed, for the centrifugal force and the twisting strain on the spindle, which was a most important matter, but there was a big difficulty when they came to provide a steel spindle which was very large, as it would have to be to stand the enormous twisting strain; they could never be quite certain what they got inside. He believed he was correct in saying that, in this country at any rate, all machines which had such heavy moving masses as this revolved at a very much lower speed, something like one-tenth.

The meeting then adjourned until December 14th.

NEW PATENTS—1893.

22,140. "Improvements in incandescent electric lamps." W. S. SMITH. Dated November 20th.

22,184. "Regulating apparatus for electromotors." C. D. ABEL. (Communicated by Berliner Maschinenbau Aktien Gesellschaft vorm. L. Schwartzkopff, Germany.) Dated November 20th.

22,186. "Improvements in lock and block electric apparatus." E. TYER. Dated November 20th.

22,190. "An improved process for producing aluminium." J. SOLER. (Partly communicated by E. Tarin and R. Pillier, France.) Dated November 20th.

22,195. "An improved permanent magnet." A. T. COLLIER. Dated November 20th.

22,210. "Improved composition adapted to replace india-rubber and analogous substances." F. J. COX, F. L. MERRITT, and M. G. E. CUDDON. Dated November 20th.

22,214. "Improvements in glass bulbs relating to incandescent and other lighting." G. W. PRIDMORE and T. J. STURGEON. Dated November 20th.

22,253. "Automatic railway electric signals." C. H. BRADRICK and B. A. KARR. Dated November 21st. (*Complete.*)

22,255. "Improvements in signal telegraphy." H. D. FITZPATRICK. (Communicated by the Boughton Telephotos Company, United States.) Dated November 21st. (*Complete.*)

22,274. "Improvements in primary electric batteries." A. V. NEWTON. (Communicated by A. Nobel, France.) Dated November 21st.

22,304. "Improvements in or connected with trolleys for electric railways." J. T. FULLER. Dated November 21st.

22,311. "Improvements relating to storage batteries." E. P. USHER. Dated November 21st. (*Complete.*)

22,312. "Improvements in storage batteries." E. P. USHER. Dated November 21st. (*Complete.*)

22,319. "Telegraph type-writing apparatus." J. GELL. Dated November 21st.

22,335. "The electrical and explosive method for extinguishing fires." J. WORTHINGTON and R. PARKINSON. Dated November 22nd.

22,359. "An improved electrical detachable joint." F. KING and W. P. MENDHAM. Dated November 22nd.

22,363. "An improved multiple circuit microphonic transmitter." F. T. TRONTON. Dated November 22nd.

22,366. "Improvements in phonographs." W. H. DUNKLEY. Dated November 22nd.

22,379. "Improvements in charging primary batteries." S. MILLER and C. J. GRIST. Dated November 22nd.

22,395. "Improvements in electric systems and apparatus." P. E. POWNALL and R. B. POWNALL. Dated November 22nd.

22,437. "An improved electrical measuring instrument." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated November 23rd.

22,438. "Improvements in pivoted electrical measuring instruments." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated November 23rd.

22,439. "Improvements in electrical measuring instruments." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated November 23rd.

22,519. "Improvements in clips for electric conductor casing." C. DARRAH, of the firm of BAXENDALE & Co., and C. C. METCALFE. Dated November 24th.

22,562. "Improvements in or connected with electrical signalling apparatus." T. DAVIS and E. DAVIS. Dated November 24th.

22,570. "Improved apparatus for working railway switches by means of electrical energy and for signalling in connection therewith." SIEMENS BROS. & Co., LTD. (Communicated by Messrs. Siemens and Halske, Germany.) Dated November 24th.

22,584. "Improvements in means for fixing fuses in electric circuits." R. E. HOLDOM and H. SMYTH. Dated November 24th.

22,594. "Improvements in arc electric lamps." W. J. DAVY. Dated November 25th. (*Complete.*)

22,651. "Improvements in electric lamps and shade holders." L. T. BUCKLER and T. CLARKE. Dated November 25th.

22,674. "Improvements in or relating to electric regenerative batteries or accumulators and in porous cells therefor." R. HADDAN. (Communicated by H. Riguelle, Belgium.) Dated November 25th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

12,731. "Improvements in the electrolytic extraction of zinc." SIEMENS BROS. & COMPANY, LIMITED. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated July 11th. Relates to a process by means of which the formation of zinc sponge during electrolysis is entirely prevented. 1 claim.

12,735. "Improvements in supports for telegraph insulators." J. C. FULLER and G. FULLER. Dated July 11th. Consists in making the cross arms of tubular steel or iron. 1 claim.

12,807. "Improvements in apparatus for regulating the arc in electric arc lamps." A. W. MONEY and H. NASH. Dated July 12th. Two electro-magnets are employed, one in series with the main circuit, the other a shunt across the arc, such electro-magnets being connected to rocking levers, the centre of which latter is pivoted to a fixed axis. One of these rocking levers is connected by a link with the regulating clutch or break apparatus. 3 claims.

13,072. "Improvements in coupling and fixing glass tubes for containing electric wires." D. RYLANDS and S. SLATER. Dated July 16th. The inventors take a ring or collar of India-rubber or other suitable material of proper size to fit tight on the ends of the glass tubes they desire to couple together. The end of one glass tube is passed about half-way into this India-rubber ring, or collar, or socket; and the end of another glass tube is forced on the opposite side into the remaining portion of the India-rubber ring or socket, which fits tight on both ends of the glass tubes, holding them securely together and forming a water-tight joint. 2 claims.

13,090. "Improvements in incandescent electric lamp fittings." K. W. HEDGES. Dated July 16th. Consists of an improved arrangement for taking up the slack of the twin flexible wires through which the current of electricity passes from a wall plug or fixed connection to a portable electric lamp. 2 claims.

13,095. "Improvements relating to the electric heating of pottery and other furnaces, and materials therefor." F. VON POSCHINGER. Dated July 16th. Consists in passing electric currents through suitably resistant surfaces on the floor, walls, or vaulting of the furnaces so that the goods or materials in the furnace may be heated by conduction or by radiation as desired by the heat produced and given off from such surfaces by the passage of suitably strong currents.

13,105. "Improvements in attaching arms to telegraph poles." H. C. JOBSON. Dated July 16th. Consists in passing a vertical metal strap or connection across the arm and securing it to the pole above or below or preferably both above and below the arm.

13,595. "Improvements in apparatus for varying the strength and direction of electric currents." J. A. EWING and C. G. LAMB. Dated July 26th. Consists in the employment of a non-conducting vessel, generally cylindrical, containing a conducting liquid, with a pair of conducting plates immersed in the liquid and fixed, preferably to the sides of the vessel at opposite ends of a diameter. Another pair of conducting plates is also immersed in the liquid and is supported on opposite sides of a revolving boss within the vessel, or otherwise in such a manner that they are free to turn, with the effect that when they are turned one of them passes close to one of the fixed plates at the same time that the other passes close to the other fixed plate. 2 claims.

15,120. "Improvements in or applicable to electrical accumulators or secondary or storage batteries." H. W. HEADLAND. Dated August 22nd. The inventor takes a hollow rod or bar of suitable cross-section, and perforates its sides with numerous holes. The interior of such bar is then filled with the composition which may project into the apertures at the sides, so as to be flush with the face or faces of the bar. 2 claims.

15,194. "A new or improved telephone transmitter." E. L. MAYER and A. C. JAMESON. Dated August 23rd. The inventors attach to the diaphragm a support of insulating material to the back and to the front parts, of which they affix conducting pieces constituting the fixed microphonic element. Lying loosely upon the said support are two conducting pieces constituting the movable element, and they so shape the base of the support, or the part on which the said pieces rest, that they shall each press against the corresponding conducting piece of the fixed microphonic element. 3 claims.

15,840. "Improvements in electric arc lamps." R. E. B. CROMPTON and E. A. N. POCHIN. Dated September 3rd. Consists of improvements in Patent No. 2,539, May 22nd, 1883. 5 claims.

16,046. "An improved process of and apparatus for the electrolytic decomposition of alkaline salts." H. Y. CASTNER. Dated September 7th. Consists in the employment of a mechanically moving body of mercury or other liquid metal or alloy between the anode and cathode compartments of a decomposing cell, completely separating the materials therein, and so placed that the current in its passage through the cell, from the actual anode to the actual cathode, must pass into and through the moving metal. 11 claims.

16,489. "An arrangement for working an electrical rock drill or similar apparatus." A. L. TAYLOR. Dated September 15th. Consists in automatically commutating or entirely or partially cutting off or admitting a supply of electricity to a solenoid or solenoids, or similar apparatus, by causing the motion of the spindle or otherwise to impart pressure to a substance whose resistance is varied by pressure. 3 claims.

16,571. Improvements in the connections of electric motors with the sources of electricity from which they are supplied." WOODHOUSE AND RAWSON UNITED, LTD., and W. S. RAWSON. Dated September 16th. Relates to the employment of two batteries or groups of batteries, which are connected to the motor through a switch so arranged that they can supply the motor either parallel or in series. 1 claim.

16,644. "Improvements in instruments for measuring electrical currents." SIEMENS BROS. & Co., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated September 17th. According to one arrangement, the horse-shoe magnet which polarises the iron needle is fixed in a slot in the middle of the thickness of a copper slab, through which slab the current passes in a plane transverse to the axis of the needle, which is mounted so as to be in the middle of the horse-shoe.

16,805. "Improved portable electric search light apparatus." R. A. SCOTT. Dated September 20th. Has reference to improved portable apparatus, comprising a carriage with accumulators and electric search light projector, the whole adapted to be easily, quickly, and safely transported, so that it can be advantageously used as may be required at places that may be at great distances apart. 2 claims.

16,877. "Improved signalling apparatus for telephones." Sir C. S. FORBES. Dated September 21st. Consists in the employment of an induction coil for producing the call signal. 3 claims.